DIVISION OF ENVIRONMENT
QUALITY MANAGEMENT PLAN

PART III:

STREAM PROBABILISTIC MONITORING PROGRAM
QUALITY ASSURANCE MANAGEMENT PLAN

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TABLE OF CONTENTS

Section 1

INTRODUCTION

1.1 Purpose of Document

This document presents the quality assurance (QA) management plan for the Kansas stream probabilistic monitoring program. Quality assurance goals, expectations, responsibilities, and program evaluation and reporting requirements are specifically addressed. Standard operating procedures (SOPs) for the collection, preservation, examination, and archival of biological specimens and the acquisition of supporting physical habitat and water chemistry data also are provided in the appendices of the plan.

1.2 Basic Principles

Probabilistic sampling is a method of environmental monitoring that yields statistically representative information on the physical, chemical and biological condition of natural resources. It differs from conventional sampling in that probabilistic monitoring stations are a randomly selected subset of the resource as a whole. In Kansas, stream chemistry and stream biological monitoring programs traditionally have employed a targeted monitoring design that positions stations in a deliberate and strategic manner (e.g., near the terminus of specific watersheds or above and below discrete pollution sources). Although these programs are of critical importance in determining site- and watershed-specific water quality conditions, funding and logistical constraints limit the number of targeted sites that can be sampled on an ongoing basis. In contrast, probabilistic monitoring focuses on the total resource rather than individual monitoring locations. Results generated from this approach can be extrapolated with known confidence to the state's entire population of streams, including the hundreds of smaller water bodies (e.g., headwater streams) largely outside the historical and current purview of the targeted monitoring programs.

1.3 Overview of Program

1.3.1 Historical Background

In 2004, the Kansas Department of Health and Environment (KDHE) participated in the U.S. Environmental Protection Agency's (EPA) National Wadeable Streams Assessment and gained experience in the application of probabilistic sampling designs and associated field methodologies (EPA, 2004; http: // www.epa.gov / owow / streamsurvey/ WSA_ Assessment_Dec2006.pdf). In 2005, availability of supplemental monitoring funds under section 106(b) of the federal Clean Water Act (CWA) provided an opportunity for the department's Bureau of Environmental Field Services (BEFS) to: (1) develop a QA management plan and accompanying set of SOPs for a similar statewide probabilistic program; (2) hire and train two environmental scientists to assist with the implementation of field and taxonomic duties; (3) develop a list of randomly selected (candidate) stream reaches; (4) obtain landowner permission to perform evaluations on these stream reaches; (5) initiate probabilistic monitoring operations; and (6) develop a methodology for applying probabilistic data to CWA section 305(b) water quality assessments. Probabilistic monitoring was formally implemented by BEFS in December 2005 under the auspices of the newly created Kansas stream probabilistic monitoring program (SPMP).

From its inception, the SPMP was designed to complement, rather than supplant, the department's traditional monitoring programs. Targeted monitoring continues to serve as the primary basis for CWA section 303(d) list development, total maximum daily load (TMDL) formulation, and National Pollutant Discharge Elimination System (NPDES) permit review and certification. Although site selection procedures for the probabilistic and targeted monitoring programs differ substantially, field methodologies developed for the targeted programs have been integrated with little alteration into the probabilistic program. This decision has maintained methodological continuity across programs and should facilitate inter-program data comparability in future assessments. Staff of the targeted monitoring programs have contributed to the development of the SPMP and continue to play an important role in the implementation of this program, primarily through the training of staff and participation in field and laboratory operations and quality control (QC) functions (see section 4, below).

1.3.2 Development of Monitoring Network and Sampling Protocols

The SPMP sampling network is predicated on a random, but spatially balanced, site selection process (*cf.*, Kaufmann *et al.*, 1991; Messer *et al.*, 1991; Larsen *et al.*, 1994; Urquhart *et al.*, 1998; Herlihy *et al.*, 1998; 2000). Site coordinates are based on the random selection of points from the set of classified stream segments identified in the most recently approved version of the Kansas Surface Water Register (KSWR) (KDHE, 2006). This register represents the population of potential sampling locations or "sampling frame." It is subject to incremental change over time owing to the deletion or addition of classified stream segments by the BEFS Use Assessment Section (KDHE, 2006). In effect, an infinite number of potential sampling sites can be selected from the KSWR, allowing a manageable subset of about 50 newly selected sites to be sampled each year. Sampling locations reflecting the program's first 800 randomly selected (candidate) points are depicted in Figure 1.3.2.1. Locations scheduled for sampling in 2006-2007 are depicted in Figure 1.3.2.2.

An effort is made by SPMP staff and other participating BEFS employees to evaluate surface water chemistry, macroinvertebrate community composition, and phytoplankton community composition at each of the scheduled sampling locations. Physical habitat data also are collected to help discriminate between chemistry- and habitat-mediated limitations to the biotic community. As mentioned previously, the SPMP employs field protocols developed originally for the department's targeted stream monitoring programs (see sections 4.2 and 4.3). These established methods are robust, and their utility has been demonstrated over the course of several decades. Moreover, data comparability and consistency among monitoring programs may prove important to future statewide water quality assessments.

1.3.3 Development of Taxonomic Capabilities and Water Quality Indicators

Program employees utilize the same taxonomic literature, taxonomic keys, and macroinvertebrate reference collections employed in the stream biological monitoring program (SBMP). They also rely heavily on the taxonomic expertise and guidance of their colleagues in the SBMP, a condition that will change over time as experience is acquired under the tutelage of these employees. For a detailed history of the development of SBMP taxonomic capabilities and a list of pertinent taxonomic literature, see section 1.3.2 of the SBMP QA management plan (KDHE, 2007a).

Biological metrics currently used for diagnostic purposes include the macroinvertebrate biotic index (MBI), Kansas biotic index (KBI), Ephemeroptera-Plecoptera-Trichoptera (EPT) index, EPT expressed as a percentage of total taxa, EPT expressed as a percentage of total abundance, and total macroinvertebrate taxa. Habitat indices currently employed in the program include the Habitat Diversity Index or HDI (Huggins and Moffett, 1988) and EPA's Rapid Habitat Assessment (RHA) protocol (USEPA, 2004; see also Appendix C). It is anticipated that future assessments also will employ newly developed biological assessment tools such as regionally calibrated multimetric indices, sentinel aquatic species (*e.g.*, Rosenberg and Resh, 1993), and multivariate statistical techniques (*e.g.*, Berkman *et al.*, 1986; Davies *et al.*, 1999).

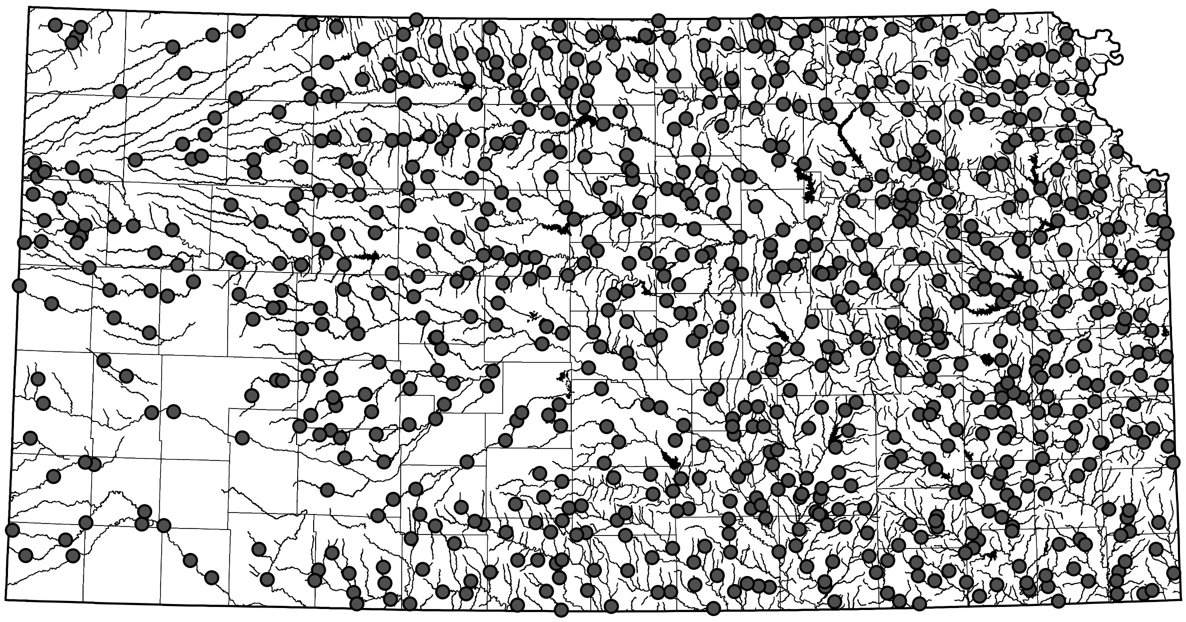

Figure 1.3.2.1. Distribution of first 800 candidate monitoring sites.

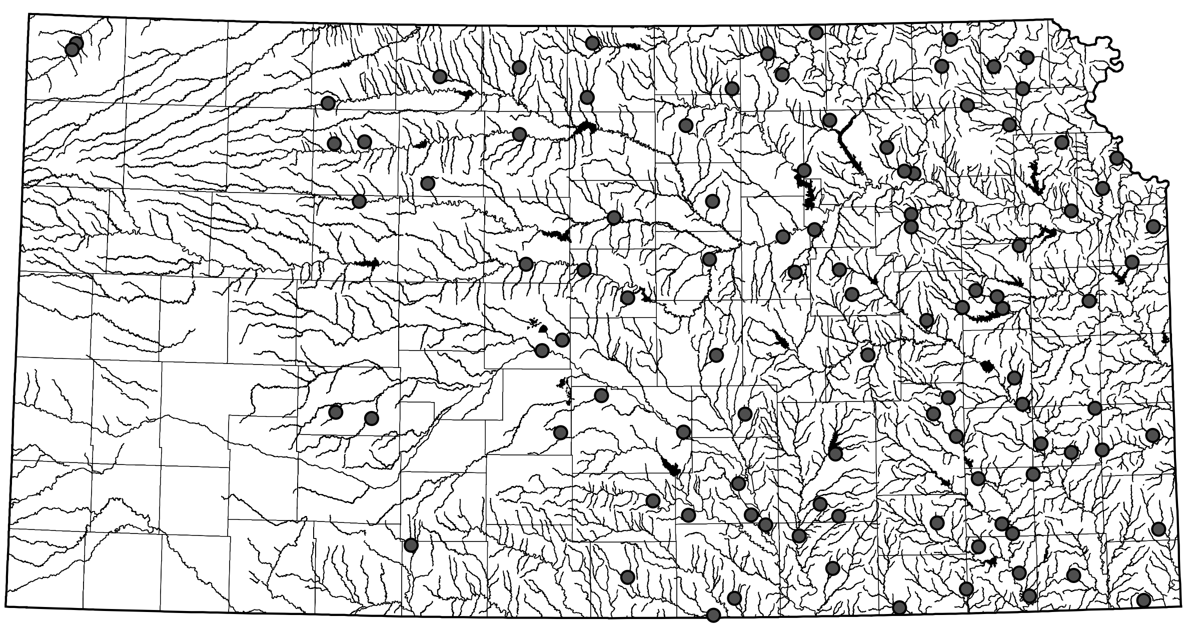

Figure 1.3.2.2. Distribution of scheduled monitoring sites, 2006-2007.

1.4 Contemporary Program Objectives

The primary objective of this program is to obtain scientifically rigorous and statistically representative information on the physical, chemical and biological condition of all classified streams in Kansas. This information is intended for use in:

1) complying with the water quality monitoring and reporting requirements of 40 CFR 130.4 and sections 106(e)(1) and 305(b) of the federal Clean Water Act;

2) evaluating waterbody compliance with the Kansas surface water quality standards (K.A.R. 28-16-28b *et seq*.);

3) identifying point and nonpoint sources of pollution contributing most significantly to water use impairments;

4) documenting spatial and temporal trends in surface water quality resulting from changes in land use patterns, resource management practices, wastewater treatment, climatological conditions, and corresponding pollutant loadings;

5) developing scientifically defensible environmental standards, wastewater treatment plant permits, and waterbody/watershed pollution control plans; and

6) evaluating the efficacy of pollution control efforts and waterbody remediation/restoration initiatives implemented by the department and other agencies and organizations.

Section 2

QUALITY ASSURANCE GOALS

The foremost goal of this QA management plan is to ensure that the Kansas SPMP produces data of known and acceptable quality. "Known quality" means that data precision, accuracy, completeness, comparability, and representativeness are documented to the fullest practicable extent. "Acceptable" means that the data support, in a scientifically defensible manner, the informational needs and regulatory functions of BEFS, the Division of Environment, and the agency as a whole. The success of the program in meeting this general goal is judged on the basis of the following QC performance criteria and requirements:

(1) Where practicable, the reliability of program data shall be documented in a quantitative fashion. Precision of chemical and biological data and physical habitat measures shall be evaluated through duplicate sampling activities conducted by field staff. Sequential duplicate chemical samples will be collected from a minimum of one site during each sampling run. Duplicate biological samples and physical habitat measurements will be obtained from at least ten percent of the sites sampled, and duplicate algal samples will be collected from every site. For all parameters being measured (*e.g.*, water chemistry analyses) or calculated (*e.g.* biological and habitat indices), average relative percent difference (RPD) values between duplicate samples shall be less than twenty percent.

Accuracy of chemical data shall be evaluated through the use of field blanks and field spiked samples. A field blank shall be collected on each sampling run, or at least once during any week of sampling. Accuracy measures based on field spikes shall be based on data collected by the stream chemistry monitoring program (SCMP) (see SCMP QA management plan; KDHE, 2007b). Background contaminant levels (determined by field blank analysis) shall constitute, on average, less than ten percent of the reported sample concentrations, and spike recoveries shall average between 80 and 120 percent of the actual spike concentrations.

Accuracy, as the term pertains to biological sampling, refers to the correct identification of biological specimens to the lowest practicable taxonomic level. Accuracy is evaluated through the use of reference specimens and through internal and external audits of taxonomic performance (see sections 4.6.1 and 4.6.3). As a general goal, program personnel shall misidentify less than one percent of the specimens collected in the course of sampling activities.

(2) Loss of biological data due to specimen collection, transport, or storage problems, or to the subsequent mishandling of data, shall be limited to less than two percent of the data originally scheduled for generation. If problems occur and a substantial quantity of data is lost, an effort shall be made to resample the stream(s) in question to maximize data completeness. Loss of chemical data due to sample collection, transport, or analytical problems, or to the subsequent mishandling of data, shall be limited to less than five percent of the data originally scheduled for generation. If this goal is not met and a substantial quantity of data is lost, an effort shall be made to resample the stream(s) in question.

These goals do not include circumstances where streams scheduled for visitation are found to be dry at the time of attempted sampling. Such sites shall be designated as non-sampleable. As a general goal, the number of sites originally scheduled for sampling that are later found to be dry shall comprise less than ten percent of the total number of sites scheduled during any reporting period. If fewer than the desired number of sites are deemed sampleable, replacement sites shall be added to the sampling schedule in order to meet the aforementioned goal.

(3) Changes in the methods used to obtain and analyze environmental samples shall be carefully documented through formal revisions to the SOPs appended to this QA management plan. This requirement is intended to help maintain a reasonably consistent database over time, track the effects of any procedural changes on the program's reported findings, and facilitate the identification and evaluation of long-term trends in surface water quality.

(4) Data generated through this program shall be compared and contrasted with other available monitoring information to examine the representativeness of program findings relative to other reported results. Staff shall attempt to ascertain the probable causes of any discrepancies observed between the various existing databases and describe, in end-of-year program reports, the magnitude and practical significance of such discrepancies.

Section 3

QUALITY ASSURANCE ORGANIZATION

3.1 Administrative Organization

The SPMP is one of several environmental monitoring programs administered by the BEFS Technical Services Section (KDHE, 2007c). Program offices are located at the Curtis State Office Building, 1000 SW Jackson, Suite 430, in Topeka, Kansas.

3.2 Staff Responsibilities

Program personnel include three environmental scientists. The environmental scientist IV serves as program manager and is accountable for most program planning, data interpretation, and report writing functions. This employee also participates in field work, monitors program QC, maintains lines of communication between SBMP and other participating programs and laboratories, apprises the section chief of any equipment or staff training needs, and participates in the annual review and revision of the program QA management plan (see section 5). The two environmental scientists I routinely schedule and participate in field activities, serve as the principal taxonomists for the program, help SBMP staff maintain the BEFS biological reference collection and taxonomic library, and assist with a broad variety of data interpretation and report writing functions.

In addition to implementing the Kansas SPMP, program personnel are charged with developing regionally calibrated biological indices and methods for routinely incorporating biological data into 305(b) assessments. Further duties include deriving approaches for identifying and linking ecological stressors to aquatic life use impairments and performing the sampling and statistical analyses needed to finalize the Kansas list of reference streams, lakes, and wetlands (KDHE, 2005c).

As mentioned previously, SBMP and SCMP personnel play an important role in the implementation of the SPMP, primarily through the provision of training and participation in field, laboratory, and QC-related operations. The manager of the BEFS lake and wetland monitoring program (LWMP) also assists with specific analytical and taxonomic duties (see section 4, below). Other employees of BEFS may occasionally assist with SPMP field activities in the event of staff absences or when additional people are needed to conduct the work in a timely, safe, and efficient fashion. Conversely, SPMP personnel provide reciprocal assistance to other BEFS monitoring programs.

3.3 Staff Qualifications and Training

Minimum technical qualifications for program staff vary by position. However, each environmental scientist must hold at least a four-year college degree in aquatic biology or a closely related scientific field and have substantial experience in the performance of surface water quality studies and associated data analysis and statistical procedures.

The program manager must understand the basic principles of supervision, program administration, and QA/QC and possess advanced computer skills and written and oral communication skills. Pursuant to Part I of the Division of Environment QMP (KDHE, 2007d), the program manager also must complete formal supervisory training offered by the Kansas Department of Administration and quality assurance training offered by EPA.

The program's environmental scientists I must possess a strong taxonomic familiarity with the invertebrate organisms occurring in Kansas streams. They must also have a thorough understanding of the procedures used in the sampling, preservation, identification, enumeration, labeling, and archiving of invertebrate specimens and in the processing of associated paperwork and other documentation.

All individuals routinely participating in this program must possess a valid Kansas driver's license and current certifications in first aid, cardiopulmonary resuscitation (CPR), and automated external defibrillator (AED) operation. They must review the program’s QA management plan and SOPs prior to assuming field/laboratory duties and repeat this review at least annually (Division of Environment QMP, Part I). All program staff receive in-house training in applicable work procedures and related safety requirements. As funding and other agency resources allow, the program manager and environmental scientists I are encouraged to participate in technical workshops and seminars dealing with environmental monitoring operations and related field, analytical, data management, and statistical procedures.

Section 4

QUALITY ASSURANCE PROCEDURES

4.1 Survey Design and Monitoring Site Selection

4.1.1 General Principles

Sampling sites in the SPMP are selected on a random but spatially balanced basis, permitting the monitoring data to be extrapolated with a known degree of confidence to the state's entire population of classified streams. As stated previously, the sampling frame is based on the list of stream segments given in the most recently approved version of the KSWR. This list includes many intermittent systems as well as perennial streams and rivers.

All sites are selected using a generalized random tessellation stratified (GRTS) design (Stevens and Olsen, 2004). Using GRTS, the KSWR sampling frame (essentially a linear network derived from the National Hydrographic Dataset or NHD) is overlaid and partitioned with a rectangular grid. Nested subgrids further partition the frame until the expected probability of selecting a sampling site in any given cell is less than 1. The resulting cells are given hierarchical addresses that are used to order the resource sampling elements, which then are arranged linearly by address and sampled systematically. Sites selected for sampling are numbered from 1 to n (sample size), the numbers are converted to base 4, the addresses are reversed, and the sites are then ordered according to the reversed address. This process (recursive partitioning and systematic sampling, followed by reverse hierarchical ordering) forms the basis for the random, but spatially ordered samples.

4.1.2 Original Survey Design

The sampling frame for the initial survey (2006-2007) was based on the 15 December 2005 KSWR and its accompanying map coverages. The survey design was produced by the Ecological Monitoring and Assessment Program (EMAP) Design Team at the EPA Office of Research and Development, Western Ecology Division, Corvallis, Oregon. The EMAP design team clipped the KSWR coverage at the Kansas border to yield a total sampling frame stream length of 46,817 km. Sites were selected at a uniform density relative to the sampling frame without unequal weighting or stratification (that is, without respect to ecoregion, stream order, flow class, or any other classification parameter).

The survey design was implemented using *"R"* statistical software, version 2.2.1, and the *psurvey.design* package, version 2.2.1 (EPA Office of Research and Development, Western Ecology Division). The number of sampling sites requested for the first survey design was 100 (50 sites × 2 years). The SPMP requested a generous oversample of 700 percent, for a total of 800 sites. The oversample was intended to compensate for landowner denials, estimated *a priori* at 50 percent, and non-sampleable (*e.g.*, dry) sites, estimated at 30-40 percent. EPA provided the completed site list and supporting documentation on 07 February 2006 (Figure 1.3.2.1).

4.1.3 Design of Future Surveys

Future survey designs are expected to focus on the same target population as the initial survey design. That is, they will consider all classified stream segments identified in the most up-to-date version of the KSWR. The KSWR is expected to change incrementally based on the ongoing work and technical recommendations of the BEFS Use Assessment Section and the Data Support Section. Therefore, the timing and extent of new survey designs will be determined based on anticipated changes to the KSWR as well as on upcoming 305(b) assessment periods.

Survey design specifications are unlikely to change appreciably over time; specifically, unweighted and unstratified designs are planned for the foreseeable future. If discrete categories of the sampled resource (*e.g.* intermittent streams, large rivers) emerge and present ongoing difficulty in meeting monitoring objectives, consideration will be given to altering the design. The program will rely on the EPA EMAP Design Team (Corvallis, Oregon) to assist with survey design and site selection, and the BEFS Data Support Section will be involved in providing and archiving the associated geographical data. The design team will use the newest published version of the most appropriate software package for performing spatially balanced random sampling from a linear resource. Currently, this is the "R"-based software package *psurvey.design*, version 2.2.1.

4.1.4 Evaluation and Selection of x-sites

Overview. Each survey design generates a numerically prioritized list of site coordinates. Not every site on the list is sampled, but all sites must be evaluated and used (or not used) in the stipulated order. Reasons for not sampling a site must be documented as described in the Wadeable Streams Assessment Site Evaluation Guidelines (USEPA, 2004). The four stages in evaluating whether a site will be sampled are designated: preliminary modifications, desk reconnaissance, field reconnaissance, and permissions.

Preliminary Modifications. The sampling frame may need to be adjusted from time to time to reflect revisions to the KSWR. For example, the original (2006) sampling frame was slightly altered after site selection to reflect the proposed deletion of 85 KSWR stream segments. This led to the removal of 40 of the 800 sites, including nine of the first 200 listed sites. Aerial photos and maps of each of the affected sites were reviewed along with use attainability analysis (UAA) data sheets and site photos prior to site removal. Upon this further review it was determined that the sites would have been scored as nonsampleable (dry) in any case. It was recognized that these deletions from the sampling frame, or any other changes to the frame between survey design and data analysis, could potentially influence data interpretation and reporting.

Desk Reconnaissance. A remote reconnaissance is conducted for all sites using available informational resources. Reconnaissance procedures resemble those used for the National Wadeable Streams Program (USEPA, 2004). The remote reconnaissance entails visual inspection of contemporary black and white 1-meter aerial photos (digital orthoimagery quarter quadrangles, State of Kansas and Sanborn Map Company, 2002) overlaid by the KSWR and the x-sites using ArcMap. Additional sources of information considered by SPMP staff include USGS estimated minimum stream flow data (Perry *et al.*, 2002), segment data from the UAA database, and telephone or written information from landowners or local aquatic resource experts.

Sites are reviewed using the resources described above and then separated into three categories:

1. “Wet”: water almost certain to be present – these sites are located on large streams and designated as suitable for sampling without field reconnaissance.

2. “Dry”: water almost certain to be absent – these sites are located on seemingly ephemeral streams and designated as unsuitable for sampling without field reconnaissance. Aerial photographs typically reveal a dry, farmed-over “channel” with no distinction between the surrounding topography/vegetation and the stream course.

3. “Questionable”: presence of water uncertain – these sites are located on small streams with limited or intermittent flow, and all are targeted for future field reconnaissance.

Field reconnaissance. Under normal circumstances, field reconnaissance is performed during the low-flow period (July-October) of the year prior to intended sampling. A field reconnaissance file is prepared for each category 3 site. The file contains a map showing the x-site and nearest upstream and downstream bridges as well as local road and stream names, an aerial map, landowner information (if available), and a Field Reconnaissance Form (APP.C-10). The field reconnaissance form includes fields for site name, stream name, county name, geographical coordinates for points of interest, distance between the x-site and nearest bridge sites, hydrologic unit plus channel unit segment number (CUSEGA), and CUSEGA supplementary data (*e.g.*, UAA program data; USGS estimated flow data, see Perry, *et al.*, 2002).

Each site is assessed at one or more of the following points: nearest upstream bridge, nearest downstream bridge, x-site, or some other appropriate access point (section 4.1.4).

Digital photos are taken, GPS coordinates are determined at each evaluation point, and information is recorded regarding site access and the presence, volume, and flow of water.

At this point in the evaluative process, one of the following determinations is made concerning sampleability of the x-site during low flow: sampleable – adequate water is present (either flowing or in pools); nonsampleable – adequate water is not present; or undecided – adequate water may be present, but a follow-up telephone call to the landowner is needed to obtain more information about local flow conditions.

Permissions. Permissions are pursued independently of, though often concurrently with, reconnaissance activities. Normally, permissions are pursued for 200 x-sites at a time, a number deemed adequate for obtaining two years' worth of sampling locations (*i.e.*, 100 sites). Methods for obtaining permissions are modified from an EPA technical report (Lesser, 1997). Property owners are identified by contacting county governmental agencies such as the registers of deeds and/or county appraisers, and a systematic effort is made to contact each owner. A more detailed description of the landowner identification and contact process is presented in the appended SOP, SPMP-005.

4.1.5 Evaluation and Selection of Bridge Sites

Because an effort is made to collect water chemistry samples from each site on four occasions, access to these sites must be reliable and reasonably direct. A "companion" chemistry sampling site is designated for each x-site at a nearby upstream or downstream bridge, low-water crossing, or other point of ready access. Companion sites are located on the same channel unit segment (CUSEGA) as the x-site and are identified using the KSWR and the "major roads" and "local roads" coverages from the KDHE geographical information system (GIS) server.

Candidate companion sites generally include the upstream and downstream road crossings nearest each x-site. If no road crossing occurs within the named CUSEGA segment, an effort is made to collect all water chemistry samples from the x-site itself. For comparison purposes, 78 percent of the sites in the original (2006) survey design had a bridge crossing within one stream mile and 97 percent had a crossing within three stream miles.

Each companion site is designated by handpicking one of the access points from the candidate upstream and downstream points. Selection is based primarily on the presence or absence of intervening stream confluences (always preferring no confluence to a confluence, or fewer to more) and secondarily on distance from the x-site. In some cases, an alternate bridge site is designated if heavy rainfall or other factors clearly could prevent access to the main companion site. In the rare event that no acceptable bridge can be identified, a non-bridge companion sampling point is chosen subject to the same siting criteria.

Water chemistry at the selected companion site is considered representative of chemistry at the x-site. The Indiana Department of Environmental Management has used a similar method for monitoring chemistry in the Lower Wabash River Basin and found only minor differences between x-sites and adjacent bridge sites (Christensen, 1999). The only consistently measurable difference was for the aggregate parameter "total solids", but this difference was not reflected in the two component parameters, total suspended solids and total dissolved solids. Differences were more pronounced in larger waterways where bridge crossings were, in many cases, several miles farther from the x-sites. The Wisconsin Department of Natural Resources also found no measurable differences in water chemistry between the x-sites and nearest adjacent bridge sites (Miller *et al.*, 2006).

4.2 Chemistry Sampling

Chemistry samples are collected and analyzed in much the same manner as in the SCMP. Unless noted below, all equipment and supplies, field methods, laboratory methods, and data management procedures are identical to those specified in the SCMP QA management plan (KDHE, 2007b). It is anticipated that any future changes in SCMP methodology will be mirrored in the SPMP's corresponding methodology. Departures from the methodology of the SCMP are detailed below and fall under four general categories: sampling schedule, parameters, logistics, and sampling conditions.

Sampling Schedule. Water chemistry samples in the SPMP are collected on a quarterly basis (Jan–Mar, Apr–Jun, Jul–Sep, Oct–Dec) rather than on a bimonthly basis. A complete sample series comprises four quarterly samples taken in a single calendar year (01 January – 31 December). Samples for routine organic parameters (pesticides and related compounds) are collected from all sites only twice, once during the year's second quarter (high flow period) and once during the third quarter (low flow period).

Parameters. Samples for radiological parameters currently are not collected as part of the SPMP. Otherwise, water chemistry and bacteriological parameters are identical to those included in the SCMP.

Logistics. Water chemistry sampling responsibilities in the SPMP are partially fulfilled by SCMP staff. In order to allocate the workload between the two programs, SPMP staff provide the SCMP a complete list of all anticipated sites for a given calendar year no later than 01 November in the year prior to sampling. This list contains SPMP site identifiers, stream names, counties, x-site coordinates, companion site coordinates, and nearest towns.

Also provided are ArcMap area maps and 1/4”-scale county maps depicting the selected chemistry sampling locations. Using these materials, the SCMP manager determines which sites can be incorporated into the existing schedule of the SCMP without overburdening field and district staff or the Kansas Health and Environment Laboratories (KHEL). After the SCMP manager has made a determination, he/she advises the SPMP manager of the sites that cannot be incorporated into the SCMP schedule. The collection of samples from these remaining sites becomes the responsibility of the SPMP. Any persistent difference in opinion regarding the allocation of field work among monitoring programs is resolved by the section chief.

Occasionally, a SPMP site corresponds to a routine SCMP monitoring station. In this case, SCMP staff collect the samples as they normally would (retaining the SCMP station identifier) and SPMP staff retrieve the SCMP data for the needed quarters, assigning the SPMP identifier to those samples.

Sampling conditions. Water chemistry samples may be collected from either flowing or pooled stream sites. This approach differs from that used by the SCMP, which focuses on flowing waters. Because SPMP sites can occur on virtually any stream segment listed in the KSWR, it is expected that sampling often will be conducted on smaller, intermittent streams that are prone to pooling.

During each SPMP-related chemistry sampling event (regardless of which program is collecting the sample), field staff use a systematic method to describe and record flow conditions at the sampling site. This is especially important in pooled systems where intervening dry reaches may physically segregate the x-site from the companion site, precluding or limiting the exchange of water among pools and promoting spatial variance in water chemistry. Detailed instructions for describing and recording flow conditions at probabilistic sites are presented in SOP No. SPMP-003.

4.3 Biological and Physical Habitat Sampling

Biological samples and physical habitat measurements are obtained from x-sites and the surrounding 150-m stream reaches (75 meters above and below the x-sites). This work is performed only once at each site during the months of May through September.

4.3.1 Initial Site Activities

Upon arrival at a stream reach targeted for biological sampling, the first major activity involves locating and verifying the x-site. Designated x-sites often are some distance from the nearest vehicle access point, requiring an overland hike. The geographical coordinates (latitude and longitude) of each x-site are independently programmed into two hand held global positioning system (GPS) devices (see SOP No. BWM-007). The field crew follows the directions indicated on these devices to the designated site.

If the designated coordinates do not fall within the stream channel, a corrected x-site is established in the center of the channel adjacent to the designated x-site. In either case, the final x-site coordinates are verified by a second crewmember (with the second GPS device) and recorded on the Site Data Form (APP.C-1). Additional information recorded on this form includes supplementary locality descriptors, current and recent weather conditions, and the names of participating field staff.

At least two photographs of the stream are taken at the x-site, one facing upstream and the other downstream. If flowing or standing water (other than water from recent precipitation) is present in the reach, the site is deemed sampleable. Otherwise, the site is designated as dry and not sampleable. Unless noted otherwise, all collected samples and completed forms are labeled with the appropriate site identifier, stream name, date of sampling, and initials of participating field staff.

4.3.2 Phytoplankton and Chlorophyll-a Sampling

Water samples for phytoplankton identification and enumeration and for determination of chlorophyll-a concentration are collected before the streambed substrate is disturbed by macroinvertebrate sampling activities. Care also must be taken during water sampling to avoid disturbance of the substrate and entrainment of sediment in water samples. Two 1-L polyethylene cubetainers are filled at each site, sealed, and maintained in a cool, dark location (*e.g.*, in the stream under a towel) until transferred to the field vehicle, where they are placed immediately on ice in a dark cooler.

4.3.3 Macroinvertebrate Sampling

A detailed description of the macroinvertebrate sampling protocols used in this program is given in the appended SOP, SPMP-001 (modified from SBMP-003a). Field sampling for aquatic macroinvertebrates follows a slightly modified version of the SBMP's time-based “equal effort” method (KDHE, 2007a), which is similar to EPA's Rapid Bioassessment Protocol III (Plafkin *et al.*, 1989). During each sampling event, two individuals using D-frame nets and forceps collect macroinvertebrate specimens from the stream. An effort is made to obtain specimens from all available macrohabitats (riffles, pools, runs) and a representative array of microhabitats (*e.g.*, tree roots, aquatic vegetation, woody debris).

Sampling is confined to a spatially defined stream reach of 150 meters, a distance equivalent to that sampled, in most cases, by the SBMP. This work requires two field personnel, one collecting upstream of the x-site for 75 m (as measured along the center of the channel) and the other collecting downstream of the x-site for 75 m. To familiarize themselves with the prevailing macrohabitats and microhabitats, each collector walks the full extent of his/her assigned half-reach before initiating the timed sampling event.

Collection of macroinvertebrate specimens typically proceeds for one person-hour (*i.e.*, each collector samples for 30 minutes, as in the SBMP). Time spent traversing obstacles such as unwadeable pools or massive logjams is not counted as time spent sampling the stream. The goal of each person is to collect at least 50 organisms, up to a nominal maximum of 100 organisms. Rarely, some sites may require more than 30 minutes of sampling to yield an adequate organism count. However, sampling must end after 45 minutes, regardless of the number of organisms collected. This time limit is imposed to ensure a degree of consistency in sampling effort from site to site. On the Site Data Form (App.C-1), each person records the length of the sampled half-reach, the duration of the sampling effort, and the maximum encountered water depth.

4.3.4 Mussel Search

If live mussels or mussel valves are encountered during macroinvertebrate sampling, or if mussels are expected to occur in the stream reach based on geographical area and stream type, the crew conducts an additional 15-minute (0.5 person-hour) intensive search for live mussels and remnant mussel valves in accordance with SOP No. SBMP-003b. Each person covers the same assigned half-reach sampled previously for macroinvertebrates.

All shells and unpaired valves found in the reach are retained for voucher purposes unless there are more than 12 recent specimens of a given species, in which case a numerically representative collection is obtained with respect to the prevailing size classes. Samples are secured in a plastic bag labeled with the site identifier, stream name, collection date, and collectors' initials. If live mussels are encountered, a Live Mussel Field Form (App.C-4) is completed onsite.

4.3.5 Physical Habitat Assessment

At each site, information is recorded concerning the prevailing stream flow condition, channel configuration, dominant substrate type(s), resident aquatic biota, riparian condition, area land use, and obvious human influences on the quality and quantity of aquatic habitat (see Site Data Form, APP.C-1). Physical habitat also is assessed using a slightly modified version of the Rapid Habitat Assessment Form (APP.C-2) derived from EPA's Rapid Bioassessment Protocol (Barbour *et al.*, 1999). The characteristics of the *sampled* macrohabitats and microhabitats are recorded on a Habitat Development Index Form (App.C-3; see also SOP No. SBMP-005). The field crew also completes an abbreviated Use Attainability Analysis Form (APP.C-5).

4.3.6 Final Site Activities

Before departure from the site, a sketch is made of the sampled stream reach, depicting the location and types of macroinvertebrate habitat (see Site Data Form, APP.C-1). Additional photos may be taken, field forms are checked for completeness and accuracy, and samples are secured for transport to the vehicle. The Site Data Form includes a checklist of the forms to be completed and types of samples to be collected from each site.

4.4 Sample Transport, Chain-Of-Custody, and Holding Times

4.4.1 Chemistry Samples

All water chemistry samples must be handled and stored in a fashion that minimizes contamination, leakage, and damage during transport. Samples collected during one-day sampling runs are delivered to KHEL that same day, prior to the close of business. Samples gathered on three-day sampling runs are delivered to the laboratory on the last day of the sampling run, prior to the close of business. In the event field staff are unavoidably detained, every effort is made to contact KHEL by telephone to arrange for the late afternoon or evening transfer of samples. As a rule, no sample arrives at KHEL later than 72 hours after collection.

Only those samples collected during three-day runs and submitted for dissolved oxygen (DO), *Escherichia coli* bacteria, nitrate, nitrite, and/or orthophosphate analyses routinely exceed the maximum holding times established by KHEL. Quality control studies conducted by BEFS have shown no short-term holding time effect for DO once the samples are acidified. However, reported concentrations of *E. coli*, nitrate, nitrite, and orthophosphate may be somewhat less than actual ambient levels owing to bacteriological die-off, microbial assimilation of phosphorus and nitrogen, and other processes occurring within the samples. The magnitude of any change in concentration is ascertained through the use of field spikes (SCMP QA management plan, section 4.5.3) and through special QC (time-course) studies conducted by BEFS and KHEL.

Standardized electronic sample submission (chain-of-custody) forms accompany all samples submitted to KHEL (APP.C-9). These forms identify the monitoring location, date and time of sample collection, personnel involved in the collection of the samples, and analytical parameters of interest. They also assign each sample a unique identification number for future reference. Field personnel delivering samples to KHEL upload data on the form to the laboratory computer system. Computer-generated hardcopies are printed, carefully checked for errors, and signed and dated by these employees. Sample-receiving personnel at KHEL also sign the hardcopies and record the date and time of sample transfer. Signed hardcopies (and electronic copies) are retained both by the employees delivering the samples as well as by KHEL. A similar transfer protocol is performed if water chemistry samples change hands prior to arrival at KHEL (*e.g.*, if district staff help transfer samples to KHEL). A more detailed description of these sample delivery, transfer, and chain-of-custody protocols is presented in SOP No. SCMP-006.

4.4.2 Macroinvertebrate and Mussel Samples

These biological samples are transported to the BEFS central office in Topeka. In the unlikely event that a sample is delivered by someone other than the staff involved in its collection, the courier's signature and the date and time of sample transfer are recorded on the Chemistry Sample Submission Form (App.C-9). Samples and paperwork are retained in the possession of, or delivered to, either one of the program's environmental scientists I. These employees store the samples in a secured location pending taxonomic determinations.

4.4.3 Phytoplankton and Chlorophyll-a Samples

These samples are transported on ice in a dark cooler and transferred to a refrigerator upon return to the BEFS central office. Before the maximum holding time (72 hours) is exceeded, 25 mL of each sample is preserved for phytoplankton assemblage identification. Each duplicate sample is filtered for chlorophyll-a determination according to the procedures outlined in SOP No. LWMP-005.

4.4.4 Field Forms, Photographs, and Electronic Data

All field forms are checked for accuracy and completeness before leaving the site. Forms taken to the site are printed on "Write-in-the-Rain" paper to reduce the chance of damage or destruction by precipitation or accidental immersion in the stream. Upon returning to the field vehicle, forms are placed in the corresponding site folder for transport to the BEFS central office. Site folders are removed from the vehicle on at least a weekly basis throughout the sampling season and are stored in a secured location pending data entry.

The digital camera used in the field is fitted with a sturdy, waterproof casing to prevent damage and loss of photographic data. Digital photographs and data recorded on other electronic devices (*e.g.*, GPS units) are downloaded to the program's desktop computers at the earliest possible opportunity pursuant to section 4.10, below.

4.5 Taxonomic Determinations and Analytical Procedures

4.5.1 Macroinvertebrate Identification

A detailed description of the program's macroinvertebrate identification, enumeration and archiving procedures is given in the appended SOP, SBMP-004. Macroinvertebrate specimens are identified to the lowest practicable taxonomic level utilizing literature specific to the Kansas fauna or the most appropriate and up-to-date taxonomic literature available. Voucher specimens of newly discovered or rarely encountered taxa are added to the reference collection on an ongoing basis. Opinions of outside taxonomic experts are solicited, as needed. Samples are retained for a minimum of five years following specimen identification. Historical data may be adjusted to accommodate ongoing changes in the scientific nomenclature through revision of the Kansas Biological System Database (KBSD) reference file, maintained by the SBMP.

4.5.2 Mussel Identification

A detailed description of the mussel taxonomic procedures used in this program is given in SOP No. SBMP-003b. Mussel specimens are identified to species and, in some instances, subspecies utilizing literature specific to the Kansas fauna or other appropriate taxonomic literature. Voucher shell materials belonging to newly discovered or rarely encountered taxa are added to the reference collection on an ongoing basis. Opinions of outside taxonomic experts are solicited as needed. All shell materials are maintained indefinitely in the KDHE mussel collection. The accompanying electronic database is revised from time to time to accommodate ongoing changes in mussel nomenclature (see SBMP QA management plan; KDHE, 2007a).

4.5.3 Phytoplankton Identification and Chlorophyll-a Analysis

Phytoplankton identification and enumeration and chlorophyll-a analyses are performed primarily by LWMP staff according to procedures presented in the LWMP QA management plan (KDHE, 2005a). Phytoplankton encountered in water samples are grouped into six major categories: chlorophytes, cyanophytes, diatoms/chrysophytes, dinoflagellates, cryptophytes, and euglenoids. Using a random subsampling procedure, individual phytoplankton cells are identified to genus, measured, and enumerated. Data are summarized as "percent total count" and "percent total algal biovolume." Chlorophyll-a analyses are conducted in accordance with the methods presented in SOP No. LWMP-005.

4.6 Assessment, Evaluation, and Reporting

Because the sampling frame is a near-perfect representation of the target population, no sites are designated as "nontarget" even though some may be designated as "target/nonsampleable" (*e.g.*, dry). No field reconnaissance will be perfect because the presence of water in intermittent streams in Kansas is inherently variable, both temporally and spatially. Additionally, because chemistry sampling precedes biological sampling (four chemistry samples per calendar year, the third of which roughly coincides with biological sampling), some biological data and/or chemistry data may not be obtained from any given site. All these factors may affect data interpretation and reporting.

Whether sampled or not, all sites are characterized according to permissions and sampleability. Combining permissions data with reconnaissance data can help to determine, *a posteriori*, whether there is a bias in permission success relative to flow status or site quality. Confirmation of such a bias may affect interpretation and reporting (Lesser and Kalsbeck 1999).

Data are analyzed and assessed in two- or four-year increments for the purpose of 305(b) reporting. Extrapolation of these results to the entire population of classified streams in Kansas relies, in part, on the use of "*R*" statistical software, version 2.2.1, and *psurvey.analysis* software, version 2.2.1 or later (USEPA, 2006

4.7 Internal Procedures for Assessing Data Precision, Accuracy, Representativeness, and Comparability

Because the SPMP implements data collection procedures that are very similar to those used in the SCMP and the SBMP, data QC-review procedures are derived from methods already established in those programs.

4.7.1 In-house Audits

The section chief conducts annual audits of the implemented field and analytical procedures, whereas most taxonomic QC oversight is delegated to the SBMP's environmental scientist II (BEFS chief taxonomist). An audit may be comprised of (1) a system audit, consisting of a qualitative onsite review of QA systems and physical facilities and equipment used in monitoring, measurement, and specimen identification and (2) a performance audit, during which quantitative assessments are made of the efficiency, accuracy, and variability of macroinvertebrate sampling procedures, taxonomic methods, and/or chemistry measurement methods.

During system audits, staff conducting field operations are required to demonstrate a proper understanding of the requirements imposed by the QA management plan and accompanying SOPs. During performance audits, staff are required to conduct field and laboratory measurements and taxonomic determinations in the presence of the section chief and/or chief taxonomist, report measured values for stream temperature and pH that fall within five percent of those established by the section chief, and report measured values for HDI and selected community metrics that fall within twenty percent of those established by the section chief (or other employees or outside consultants designated by the section chief). Should these values fall outside the stipulated control limits, the section chief and SPMP manager initiate the corrective actions described in Section 4.8.

4.7.2 Instrument Calibration and Standardization

At semi-monthly intervals, the performance of thermometers used in the field is checked against a reference thermometer traceable to the National Institute of Standards and Technology (NIST). Before leaving for the field, monitoring staff also are expected to calibrate the pH meter and test the instrument for normal operation. The pH meter is standardized in the field, immediately prior to use, using NIST-traceable pH buffer solutions. This instrument must meet all manufacturer performance specifications. Should the meter be found to drift significantly, more frequent calibrations are performed or corrective actions are invoked pursuant to section 4.8.1.

4.7.3 Duplicate Samples

The protocol for macroinvertebrate sample collection involves two field staff working simultaneously within the same general stream reach. Subsamples obtained by these workers are combined to form a single pooled sample. Duplicate samples are collected consecutively and comprise approximately ten percent of the total number of samples collected on an annual basis. Overall precision (*i.e.*, combined sample collection and taxonomic precision) is estimated for various metrics based on data obtained from these duplicate samples.

During the collection of duplicate samples, field staff must avoid resampling substrate that has been physically disturbed or impacted by drift (movement of dislodged organisms) from earlier sampling activities. If precision levels indicated by the consecutive sampling method fail to meet the QC requirements of section 2, paragraph (1), the program manager and section chief invoke the corrective action measures described in section 4.8.2.

Quality control measures implemented in the field also include the collection of sequential duplicate chemistry samples. Sequential duplicate samples (collected approximately five minutes apart) are obtained from a minimum of one station during each sampling run to assess variability among samples resulting from collection, preservation, transport, and laboratory procedures. Should the precision of the data fall outside the control limits established in section 2, paragraph (1), corrective action procedures are invoked in accordance with section 4.8.2. A more detailed description of these duplicate sampling procedures is presented in SOP NO. SCMP-008.

Duplicate algal samples are collected from each site. Discrepancies in chlorophyll-a between such samples should meet the limits set forth in section 2, paragraph (1). Should the precision of the data fall outside these control limits, corrective action procedures are invoked in accordance with section 4.8.2.

4.7.4 Field Blanks

Chemistry samples may be contaminated inadvertently during sample preservation, handling, transport, storage, and analysis. This possibility is assessed through the use of field blanks prepared with glass-distilled water (inorganic analyses) or demineralized water (organic analyses) and subjected to the same treatment as surface water samples. Contamination is an especially important consideration when sampling for trace metals and metalloids, because of the extremely low ambient concentrations of these parameters. Concentrations of these parameters in water samples may be greatly augmented through exposure to airborne particulate matter and other sources.

On each sampling run, or on at least one run during any week of sampling, the weighted stainless-steel bucket is filled under field conditions with glass-distilled water initially meeting ASTM Type-I specifications. The water (blank sample) is transferred to a complete set of randomly selected sample containers and subjected to the same preservation, handling, storage, and analysis procedures as the actual field samples. This procedure is repeated using the stainless steel pail and demineralized water to prepare field blanks for the organic parameters. If the limits for sample contamination presented in section 2, paragraph (1), are exceeded, corrective actions are implemented in accordance with section 4.8.2. A more detailed description of the procedures used to assess sample contamination is presented in SOP No. SCMP-007.

4.7.5 Field Spikes

The stream probabilistic monitoring program utilizes field spike data obtained by SCMP. Specifically, QC measures implemented in the field by SCMP include the collection of duplicate samples and preparation of spiked samples. Duplicate samples are obtained from a minimum of one station on each sampling run. At least six times each year, and under the direct supervision of the SCMP manager, a set of spiked samples is prepared in the field through addition of known concentrations of selected parameters to one of the sets of duplicate samples. Later, following laboratory analysis, measured levels of the selected parameters in spiked samples are compared to those in the unamended duplicates to provide an overall indication of sample degradation and analytical recovery.

Field spikes are prepared using high accuracy and high precision fixed- and adjustable-volume pipettes, volumetric glassware, and certified reference standards obtained from EPA, USGS, or appropriate commercial vendors as described in the SCMP QA management plan (KDHE, 2007b). Should the precision and/or accuracy of the data fall outside the control limits established in section 2 of the SCMP QA management plan (and the identical provisions in section 2 of this document), corrective action procedures are invoked in accordance with section 4.7.3 of the plan. A more detailed description of the procedures used to monitor the accuracy of water chemistry measurements is provided in SOP No. SCMP-009.

4.7.6 Taxonomic Accuracy

Both environmental scientists I work closely with SBMP staff to confirm macroinvertebrate identifications. This work also is verified by comparing the list of identified taxa against the Kansas Biological System inventory of aquatic macroinvertebrates previously documented in Kansas. Rare or unusual specimens are compared to specimens in the agency reference collection and, if necessary, submitted to outside experts for further examination.

Each year, at a rate of approximately five percent of the annual taxonomic workload, the SBMP manager randomly selects invertebrate samples of moderate to high diversity for re-identification and re-enumeration of specimens. The results of this exercise are compared with information recorded on the original identification bench sheet. Exact reproducibility is not expected as some specimens have already been subjected to dissection and removal of key anatomical features.

Annual program audits conducted by the section chief (or his/her designee) and the chief taxonomist evaluate, among other things, the taxonomic proficiency of SPMP staff. If the accuracy of specimen identification fails to meet the requirements of section 2, paragraph (1), corrective action measures are initiated pursuant to section 4.8.2, below.

4.7.7 Preventative Maintenance

Periodic inspection and routine maintenance of field and laboratory equipment are necessary to minimize malfunctions that could result in the loss of data or disruption of SPMP activities (see appended SOP No. SBMP-001). Field instrumentation must routinely be inspected prior to use and calibrated at intervals recommended by the manufacturer. Equipment maintenance logs must be maintained for all field thermometers and pH meters. Sampling equipment, such as D-frame nets, hip and chest waders, and microscopes and illuminators used in specimen identification must be inspected periodically and repaired or replaced if necessary. Vehicles used during field activities also must be maintained in a reliable condition. Entries must be made in the vehicle log upon completion of each day's use. All vehicle malfunctions must be reported to the SPMP manager or higher-level supervisory personnel as soon as possible to expedite necessary repairs or the acquisition of a replacement vehicle.

4.7.8 Safety Considerations

Attention to job safety protects the health and well being of program staff and helps maintain a work atmosphere that ultimately enhances data quality and consistency. Program staff must be familiar with proper precautionary measures and the use of available safety equipment prior to assuming field duties. They also must be certified by the American Red Cross (or an equivalent institution) in adult cardiopulmonary resuscitation, basic first aid, and the use of portable AED devices.

Vehicles routinely used in the SPMP must be maintained in proper condition and equipped with first aid kits, emergency eye wash bottles, fire extinguishers, spare tires and tire changing equipment, rain gear, road reflectors and/or flares, and operable flashlights.

If personal cellular phones are not available for use, monitoring personnel are expected to check out a cellular phone from BEFS clerical staff to use in the event of a vehicle mishap, medical problem, or other emergency. Access to a cellular phone is particularly important when traveling alone, conducting overnight sampling runs, or traveling during periods of potentially severe weather.

Field staff also must exercise care when handling glassware and chemical reagents in the field. Staff should not engage in the use of potentially dangerous reagents or breakable glassware if the weather, terrain, traffic, or any other concern impedes concentration, reduces visibility, jeopardizes footing, or otherwise precludes the safe handling of these materials. Rather, staff should move to a level, dry, protected, and well-light area before preserving or analyzing samples. If the wind is blowing strongly, staff should avoid handling samples and reagents immediately upwind of their face and eyes.

Additional safety considerations are presented in the SOPs accompanying this QA management plan and other referenced QA management plans.

4.8 External Procedures for Assessing Data Precision, Accuracy, Representativeness, and Comparability

At the discretion of the section chief, bureau QA representative, bureau director, or divisional QA officer, staff may participate, from time to time, in independent performance/system audits. Staff also may participate in interagency exchanges or comparisons of macroinvertebrate reference samples as well as in interlaboratory water chemistry sample comparisons. Participation in such activities promotes scientific peer review and enhances the technical integrity and overall credibility of the SPMP.

4.9 Corrective Action Procedures for Out-of-Control Situations

4.9.1 Equipment Malfunction

Any equipment malfunction discovered during routine field or laboratory activities or during performance audits must be reported immediately to the program manager. This employee is responsible for appraising the scope and seriousness of the problem and, if necessary, for determining whether the equipment item should be repaired or replaced. The program manager also is responsible for ensuring that backup equipment is available for all critical field and taxonomic activities. Arrangements for a backup vehicle must be made in advance of any mechanical problems or mishaps that might render the program's regular vehicle inoperable for an extended period.

4.9.2 Data Precision/Accuracy Problems

If environmental sampling activities, chemical analyses, or taxonomic determinations fail to meet the requirements of section 2, paragraph (1) of this QA management plan, the program manager must initiate an investigation to determine the cause of the problem. The program manager is expected to work closely with staff in this endeavor and in the selection and implementation of appropriate corrective measures. If the problem relates to water chemistry data, the program manager normally should consult with KHEL and the SCMP manager to identify the cause(s) and implement appropriate corrective measures. Persistent problems may trigger a program audit by the section chief (or his/her designee), result in the disqualification of a substantial amount of stream environmental data, or invoke other remedial responses (*e.g.*, an independent audit).

4.9.3 Staff Performance Problems

If an employee has difficulty with a given work procedure, as determined by an internal or independent performance audit, an effort must be made by the program manager to identify the scope and seriousness of the problem, to identify any data affected by the problem, and to recommend to the section chief an appropriate course of corrective action. All questionable data are either flagged within the computer database(s) or, at the discretion of the section chief, deleted from these database(s). Possible corrective actions include further in-house or external training for the employee, a reassignment of work duties, or modification of the work procedure.

4.10 Data Management

4.10.1 General Data Management

All field- and laboratory-generated data are handled in an orderly and consistent manner. At a minimum, all forms and biological samples are labeled with the appropriate station identifier and collection date. Completed forms are carefully reviewed for obvious errors or omissions and subsequently filed in a secured location for future reference.

All general site data, landowner data, and physical habitat data are manually entered into a program-specific ACCESS database maintained on the BEFS shared drive. All related GIS files and projects also are stored on the BEFS shared drive. A concerted effort is made to maintain only up-to-date files in the GIS folder to minimize the amount of disk storage that is being used by SPMP and to minimize any confusion that might occur because of high levels of file redundancy. Additional GIS coverages are available on the KDHE 'hentimage' server, which is maintained by the agency's Office of Information Technology (OIT). Phytoplankton taxonomic results also are manually entered into the SPMP ACCESS database. Results from chlorophyll-a analyses are manually entered into the PENV database maintained on the BEFS shared drive.

Data management, processing, and checking procedures for SPMP water chemistry data are identical to the procedures outlined in section 4.9 of the SCMP QA management plan. Water chemistry data are transferred electronically to the KHEL computer system, then compiled and processed on the PENV ORACLE server. Additionally, an EXCEL tracking file is maintained on the BEFS shared drive in order to keep a record of the samples that have been collected and submitted to the laboratory. This file contains a comprehensive list of all submitted SPMP samples and associated metadata (*e.g.*, collection date, collection personnel, lab accession numbers). Participating field (SPMP and SCMP) staff transfer data on the completed Chemistry Sample Submission Form (APP.C-9) to the EXCEL file upon return from the field. Close coordination between SPMP and SCMP is necessary to ensure the collection and proper processing of all assigned water chemistry samples.

Information on biological data forms (appendices C-4, C-6, C-7, C-8) is transferred manually to the KBSD, currently maintained on an ORACLE system supported by OIT. This database also contains station identification headers, sample collection date/time files, KBSD codes for individual macroinvertebrate species (and higher level taxonomic designations), pollution tolerance values and other rating systems for the calculation of biotic indices, and other supporting information. Custom views using Visual Basic VB viewer have been designed by OIT to facilitate database access and the viewing, validation, and editing of program data. The program database is backed-up by OIT on a daily basis. Transfers of raw data may be accomplished by downloading selected portions of the database in .dbf file format. Raw data may be sorted or restricted based on station number, date of sample collection, or Kansas Biological System code, with or without associated station header information, metric values, and other supporting information. Metric retrievals may be printed, viewed, or downloaded as .dbf files. Calculated values for various biological metrics also are downloaded directly from the ORACLE system and maintained on a personal computer spreadsheet (EXCEL). These values may be retrieved and reported in various formats or subjected to basic statistical analysis. The computer spreadsheet is stored on a computer hard disk that is backed up on a CDROM every two months.

Mussel archival datasheets are checked for accuracy and completeness, and data are manually entered into an EXCEL spreadsheet maintained on the BEFS shared drive.

4.10.2 Data Entry Requirements

All environmental data and metadata manually entered into an electronic database are examined by visually comparing database retrievals with the original datasheets. Additionally, data entered into the program's ACCESS database are entered independently by each of the two environmental scientists I. The resulting tables are crosschecked for discrepancies, and the database is subsequently corrected for any data entry errors. Staff transferring or receiving data electronically also perform random spot checks of the data and report any problems to OIT for further investigation and resolution. Persistent problems are reported to the section chief and bureau QA representative for consideration of necessary corrective actions.

4.10.3 Verification of Calculations

Computer-based mathematical, statistical, graphical, and geographical programs and models involving environmental data are tested before application by comparison to other computer programs, through hand calculations involving randomly selected data, or through other appropriate means. The reliability of these models and programs is reexamined on at least an annual basis or whenever a problem is reported within a computational system. Quattro Pro, Excel, ArcMap, Minitab, and SigmaPlot are among the forms of software used for generating spreadsheets, graphs and models or for performing statistical characterizations, comparisons, and trend analyses.

4.10.4 Data Transformation and Outliers

Many forms of environmental data do not conform to a normal distribution, a condition that may necessitate the use of nonparametric statistical methods. Alternatively, the data may be transformed statistically to induce a normal, log normal, or some other preferred data distribution. The data distribution often is depicted graphically to help identify the most appropriate transformation procedure. Commercially available computer programs also may be applied in more detailed assessments of data distribution. Minitab software maintained on the BEFS shared drive offers several algorithms for characterizing departure from normality (*e.g.*, Shapiro-Wilk and Kolomogorov tests).

All environmental databases may contain some anomalous values or statistical outliers. Obvious outliers (those that are orders of magnitude beyond any reasonable value) often constitute data transcription errors or other simple errors. Staff automatically question data if a reported value or calculated metric is outside the historical range for the waterbody or watershed in question (if previous data exist). For stream macroinvertebrate data, such an occurrence may prompt another comparison of the information stored in the Kansas Biological System database with the information recorded on the bench identification sheet (APP.C-6). The SPMP and SBMP managers also may elect to reexamine the computer algorithms used to generate the metric. If necessary, the macroinvertebrate sample in question may be retrieved from storage and reexamined by the environmental scientists I (SPMP) or chief taxonomist (SBMP). In other instances, biological or chemical outliers may reflect actual (though rarely occurring) environmental fluctuations. Nonparametric procedures based on rank-order or percentiles tend to be less influenced by these kinds of data and are often favored by staff for statistical characterizations, comparisons, and trend analyses.

4.10.5 Ancillary Data

Ancillary data used in this program may include physicochemical, hydrological, meteorological, or biological data derived from other BEFS programs or other governmental agencies. All routine environmental monitoring programs administered by BEFS are subject to the provisions of parts I and II of the divisional QMP. An effort is made to ensure that data from outside agencies are generated in accordance with QA management plans similar to those developed by BEFS. In some instances, outside agencies collect data under a contractual agreement with the division, or under the auspices of an EPA grant, both of which require development and approval of a QA project plan prior to data collection (see QMP, Part I, Section 2.3).

Pollutant loading coefficients, biological metrics, species tolerance values, and some other values applied in modeling calculations are taken from documents produced by governmental agencies or from literature sources incorporating peer review of articles before publication. Staff carefully examine the underlying technical assumptions before applying these metrics and values.

4.11 Quality Assurance Reporting Procedures

End-of-year program evaluations are conducted by the section chief and a written report is submitted to the bureau QA representative, bureau director, and divisional QA officer by February 15 of the following year. The program manager cooperates fully in the evaluation of QA/QC performance by providing summary records on the precision, accuracy, representativeness, and comparability of the monitoring data gathered during the evaluation period. Program evaluations submitted by the section chief must indicate when, how, and by whom the evaluation was conducted, the specific aspects of the program subjected to review, a summary of significant findings, and technical recommendations for necessary corrective actions. The section chief discusses the reported findings with the SPMP manager and other program staff.

4.12 Purchasing of Equipment and Supplies

When newly ordered or repaired sampling, diagnostic, or computational equipment is delivered to the program office, SPMP personnel compare the item to that requested on the original order, then inspect the item to ensure that no breakage has occurred in transit and that all components have been included and function properly. The shipment is either accepted or rejected once this inspection is completed.

Office and laboratory supplies receive a comparable level of scrutiny. Reference standards and reference apparatus must be accompanied by a certificate from the vendor or manufacturer verifying the quality of these products.

4.13 Program Deliverables

Program deliverables include electronic databases, illustrative materials, statistical water quality summaries, and detailed written reports used in a variety of departmental applications. Most notably, SPMP plays a major role in the development of the Kansas biennial water quality assessment (305(b) report). As resources and circumstances allow, customized data retrievals are prepared by the program manager (or his/her designee) on behalf of administrative staff, legislative officials, other state and federal agencies, regulated entities, special interest groups, consultants, academicians, students, and members of the general public.

Section 5

REVIEW AND REVISION OF PLAN

To ensure that the SPMP continues to meet the evolving informational needs of the bureau and the agency, all portions of this QA management plan and its appended SOPs must be comprehensively reviewed by participating staff on at least an annual basis. Revisions to the plan and SOPs require the approval of the program manager, section chief, and bureau QA representative prior to implementation. Although review activities normally follow the annual program evaluation in February, revisions to the plan and SOPs may be implemented at any time based on urgency of need or staff workload considerations.

Original approved versions of the QA management plan and SOPs, and all historical versions of these documents, are maintained by the bureau QA representative or his/her designee. The bureau QA representative also ensures that updated electronic versions of the plan and accompanying SOPs are maintained on the KDHE Internet server in a "read only" .pdf format.

APPENDIX A

FIELD AND LABORATORY EQUIPMENT AND SUPPLY CHECKLIST

FIELD AND LABORATORY EQUIPMENT AND SUPPLY CHECKLIST

I. VEHICLE

A. Full sized van (or other vehicle, as available)

B. Vehicle registration and proof of insurance

C. Vehicle logbook (daily log sheets, Wright Express card, list of cooperating service stations, copies of tire, battery and emergency service contracts, accident and damage reporting forms, and other miscellaneous paperwork)

D. State highway map, 1/4"-scale county maps, and Kansas gazetteer

E. Vehicle key and spare key(s)

F. Mobile cellular phone

G. Spare tire (fully inflated), tire changing equipment, road reflectors and/or flares

H. Jumper cables, towrope, fire extinguisher (checked/refilled annually), windshield ice scrapers, window squeegee

I. Tool box that includes:

- ❑ Craftsman 1/2” drive socket set including (ratchet, 6” extension, 10” extension, 12pt. sockets sizes 7/16, 1/2, 9/16, 11/16, 3/4, 13/16, 15/16, and spark plug socket)
- ❑ Craftsman 1/4” drive socket set including (driver handle, 6pt. sockets sizes 3/16, 7/32, 1/4, 9/32, 5/16, 11/32, 3/8, 7/16, 1/2)
- ❑ Craftsman open/box combination end wrenches, sizes (in inches) 1, 15/16, 11/16, 1/2, 3/8 and small set with sizes 3/8(2), 11/32, 9/32(2), 15/64, 7/32, 3/16(2)
- ❑ 10” and 8” crescent wrenches
- ❑ slip joint pliers, 1 large, 1 regular
- ❑ 1 channel lock pliers
- ❑ 1 needlenose pliers
- ❑ 1 side cut pliers
- ❑ 3/8” drive ratchet (no sockets)
- ❑ 3/8” and 3/32” punches
- ❑ 1/2” cold chisel
- ❑ 2 padlocks with keys
- ❑ spare D-net bag
- ❑ rubber coated gloves (1 pair)
- ❑ micro-screwdrivers (4 regular, 2 phillips)
- ❑ trowel
- ❑ claw hammer (2)
- ❑ utility knife
- ❑ screwdrivers, 2 regular, 1 phillips
- ❑ small pipe wrench
- ❑ hole saw
- ❑ wire brush
- ❑ hack saw
- ❑ other (rubber gloves, sandpaper, mesh net, ziplock bags, crucible tongs)

J. First aid kit, CPR mouthpieces, latex rubber gloves, safety glasses, emergency eyewash kit, paper and cloth towels, hand sanitizing solution in plastic squeeze bottle

K. Flashlights (fully operable), whisk broom & dustpan, duct tape, 30-gal trash bags, insect repellent, fluorescent orange safety vests with reflective strips, work gloves, 2-gallon jug of wash water, bar soap

II. FIELD EQUIPMENT AND SUPPLIES

A. Garmin GPS V (with Garmin *MapSource* software) and Thales Mobile Mapper hand-held GPS unit

B. Digital camera, memory cards, carrying case, extra batteries and instructions

C. 12-volt plug for GPS and 12-volt battery charger with rechargeable AA batteries

D. Hip and chest waders (two pairs for each field worker) and a repair kit.

E. D-frame, 0.5-mm mesh nylon nets (two in use; one spare) with 1.5-meter wooden handles calibrated in decimeters for measuring stream depth

F. Forceps (fine point, on lanyard)

G. Glass sample jars (120 ml) with screw-on plastic lids

H. Label tape (white) for sample jars

I. Ethanol solution (70-80 percent) for preserving invertebrate specimens

J. Stop watches or wristwatches with stopwatch function for timing sampling events

K. Site Data forms, Habitat Development Index forms, Rapid Habitat Assessment forms, Live Mussel recording forms, UAA forms

L. Metal clipboard (with maps, field forms, etc.), pens, pencils, and indelible markers

M. Fisher model #15-0778 stainless-steel dial scale thermometer (-10 to +110^{o}C)

N. Plastic three-gallon bucket with padded steel handle for transporting samples and smaller equipment/supply items from stream monitoring location to vehicle; additional buckets or pails for carrying unionid mussel samples; plastic bags, wire ties, and indelible markers for securing and labeling mussel samples upon return to vehicle

O. Rain gear, caps or visors, sunglasses, sun screen, insect repellent, hand disinfectant solution, drinking water, extra socks in the event of wader leakage

P. Calibrated flow meter with spare batteries and propeller, 50-m tape measure, spikes and small hammer, flow record notebook

Q. Supply of 1-L polyethylene cubetainers for collection of algal samples, cooler (with ice) for transporting algal and chlorophyll-a samples

R. For chemistry sampling runs, the following additional equipment and supplies will be required:

1. "Symbol, Palm-Powered" scanning and digital data recording device loaded with the sample submission spreadsheet

2. Floppy disk loaded with a copy of the sample submission spreadsheet, plus a hard copy of this spreadsheet

3. Fisher model #15-0778 stainless-steel dial scale thermometer (-10 to +110^{o}C)

4. Cole-Parmer model #5996-70 field pH meter (analog readout with instruction manual, carrying case, combination pH probe, and pH 4, 7, and 10 buffer solutions)

5. Winkler dissolved oxygen kit (with reagents "1, 2, 3" in 250 ml Nalgene safety squeeze bottles, transported in sealed plastic container)

6. Weighted stainless-steel sampling bucket (1 gal)

7. Stainless-steel pail (1 gal)

8. Stainless-steel funnel

9. Rope (~100 ft with attached snap swivel)

10. Ice chests stocked with bags of ice

11. Sample containers (including at least two spare sets)

III. FIELD PAPERWORK

A. Valid driver's license and State of Kansas photographic identification card

B. Valid scientific collection permits from KDWP and USFWS (as required)

C. Site dossiers that include site maps, aerial photos, coordinates, supporting data (*e.g.*, flow, CUSEGA), landowner permission form, and any reconnaissance forms

D. Travel information, office contact information, and emergency contact information for all participating field personnel

IV. TAXONOMIC EQUIPMENT AND SUPPLIES

A. Wild M5A 6X-50X variable zoom dissecting microscope with additional 15X oculars (one fitted with ocular micrometer)

B. Olympus 9X-110X variable zoom dissecting microscope

C. Micromaster variable magnification compound microscope (or equivalent)

D. Bifurcate fiber-optic, variable-intensity light source

E. Glass Petri dishes

F. Stainless-steel forceps and probes (coarse and fine point), disposable pipettes

G. Lab-Line hot plate; microscope slides and slide cover slips

H. 10 percent KOH and Euparal (or CMC-9 or CMC-10) mounting medium (Master Chemical Company, Elk Grove, IL) for chironomid clearing and mounting

I. Macroinvertebrate Identification Bench forms (APP.C-6.1)

J. Taxonomic keys and supporting scientific literature

K. Boxes for storage of invertebrate samples (in original glass sample jars)

L. Ethanol (70-80 percent with 5 percent glycerine) for preserving invertebrate specimens

M. Specimen vials and trays for reference collection

N. Locking cabinet for non-unionid reference specimen collection and map file for unionid reference collection

APPENDIX B

STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

MAINTENANCE PROCEDURES FOR MACROINVERTEBRATE SAMPLING EQUIPMENT (SBMP-001)

I. INTRODUCTION

A. Purpose

Sampling equipment must be maintained in a reliable working condition to maximize the efficiency of invertebrate collection activities and minimize the loss of data.

B. Minimum Staff Qualifications

These procedures normally are performed by program field personnel but may be performed by virtually any other employee after limited initial training.

C. Equipment/Accessories

1. Hip and chest waders

2. D-frame aquatic nets

II. PROCEDURES

A. Procedures described in SOP No. SBMP-001 are adopted by reference.

OPERATIONAL AND MAINTENANCE PROCEDURES FOR FIELD ANALYTICAL EQUIPMENT (SCMP-003)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the procedures used by program staff for collection of stream pH and temperature data.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the chemical and physical properties of surface water and have a basic technical understanding of the associated measurement apparatus.

C. Equipment and Accessories

1. Fisher model #15-0778 stainless-steel dial scale thermometer
2. Cole-Parmer model #5996-70 field analog pH meter

II. PROCEDURES

A. Procedures described in SOP No. SCMP-003 are adopted by reference.

PROCEDURES FOR COLLECTION OF MACROINVERTEBRATE SAMPLES (SPMP-001)

I. INTRODUCTION

A. Purpose

Staff involved in the collection of macroinvertebrate samples must adhere to a standardized sampling procedure to maximize the comparability of the data generated by different workers over a potentially long period of time. Consistent procedures reduce the statistical "noise" that could otherwise detract from the utility of the data.

B. Minimum Staff Qualifications

Staff implementing this position must meet the minimum classification requirements for environmental scientist I published by the Kansas Department of Administration. They also must possess a strong familiarity with the range of macroinvertebrate organisms occurring in Kansas streams and command a thorough understanding of the procedures used in obtaining representative macroinvertebrate samples.

C. Field Equipment and Supplies

For a complete list of equipment and supplies, see Appendix A. Primary sampling gear is listed below:

1. Thales MobileMapper GPS device (used to measure stream reach length)

2. Hip or chest type waders depending on the depth and flow conditions of the stream being sampled

3. D-frame, 0.5-mm mesh aquatic net with decimeter graduations on handle for depth determination

4. Forceps (fine point with lanyard)

5. Glass sample jars (120-ml capacity, each containing approximately 50 ml of 70-80 percent ethanol), white tape for labeling jars, indelible markers

6. Stopwatch (or wrist watch with stopwatch function)

7. Site data forms (APP.C-1), HDI Form (APP.C-3), pencils, and indelible pens

II. PROCEDURES

A. After the x-site is established, workers walk along or wade in the stream channel (one upstream, one downstream) a distance of 75 m each, taking note of available macrohabitats and microhabitats.

B. Walking or wading back to the x-site, each worker collects macroinvertebrate specimens over a minimum time interval of 30 minutes or a combined duration of one person-hour (note: time spent maneuvering around large obstacles such as deep pools or massive logjams is not counted as time spent sampling). If a worker does not collect 100 organisms in 30 minutes, sampling continues until 100 organisms are collected or one hour has elapsed, whichever occurs first.

C. All available macrohabitats (riffles, pools, runs) and a representative array of microhabitats (various substrate types, overlying water depths, and flow velocities within a macrohabitat) are sampled, as permitted by size and depth of water body.

D. Macroinvertebrate specimens are collected by:

1. kicking riffles and leaf packets and allowing current to carry dislodged organisms (and debris on which organisms may occur) into D-frame nets for removal with forceps;

2. sweeping the D-frame nets through submerged or floating aquatic vegetation, submersed terrestrial vegetation and tree roots, accumulations of woody debris, and growths of filamentous algae;

3. sieving fine sediments (silt and fine sand) through the D-frame nets; and

4. using forceps to directly pick organisms from logs, large rocks, or other surfaces not easily dislodged by kicking.

E. Each worker endeavors to collect a minimum of 50 organisms, for a total of 100 or more organisms per pooled sample. Pooled samples with total counts of less than 100 organisms are not included in any subsequent environmental assessments or analyses.

F. Different macroinvertebrate taxa present at a site are collected in numbers roughly proportional to their relative abundance in the stream community. Neither worker should collect more than 50 organisms from any single microhabitat or individual D-frame net collection.

G. As specimens are separated from debris, they are placed directly into glass sample jars containing 70-80 percent ethanol. Using an indelible marker and white label marking tape, jars are identified with regard to station number, and collection date.

H. Upon completion of the sampling effort, a Site Data Form (APP.C-1) is filled out by one of the workers. Information recorded on the form includes station number and location, time and date of sample collection, names of sample collectors, and flow conditions at the time of sampling. An HDI Form (APP.C-3) that characterizes the types of sampled habitats also is completed (see SOP No. SPMP-002).

III. SAFETY

A. SOP No. SCMP-002, addressing vehicle safety and maintenance, is adopted by reference. Section III of SOP No. SBMP-003a, addressing biological sampling safety, is adopted by reference.

PROCEDURES FOR QUALITATIVE OBSERVATION AND DOCUMENTATION OF UNIONID MUSSEL COMMUNITIES (SBMP-003b)

I. INTRODUCTION

A. Purpose

Freshwater mussels occur in many Kansas streams but are seldom collected in quantitative macroinvertebrate samples owing to their comparatively large size as adults, burrowing habits, and sparse or scattered distribution in stream channels. Most mussel taxa are long-lived but slow to mature and reproduce. The larvae of all but a few species are parasitic on the fins and gills of fish, whereas juvenile and adult mussels live as sedentary filter feeders. Mussel communities are unusually vulnerable to declines in environmental condition and serve a useful diagnostic function in biological assessments of water quality. The following paragraphs describe qualitative procedures employed by staff for determining the species of mussels inhabiting a particular stream reach and for ascertaining changes in the composition of mussel communities over time.

B. Minimum Staff Qualifications

Unless specifically exempted by the section chief, in writing, staff implementing this SOP must meet the minimum classification requirements for Environmental Scientist I published by the Kansas Department of Administration. In all cases, these staff must demonstrate the ability to accurately and rapidly identify each of the state's more than forty species of mussels under field conditions. This ability is usually gained by careful study of archived specimens and by accumulation of field experience under the supervision of a biologist knowledgeable in mussel taxonomy.

C. Field Equipment and Supplies

1. Hip or chest waders, depending on depth and velocity of stream being sampled

2. Digital camera for documenting any rare (*e.g.*, threatened or endangered) mussel species represented by live individuals

3. Calipers or metric ruler for measuring length and height of any encountered rare species

4. Bucket with padded steel handle for transporting collected (recent, weathered, relict) shell material to field vehicle

5. Plastic bags and indelible markers for segregating and labeling shell material from different sites and transporting to BEFS laboratory in Topeka

6. Clipboard containing field forms (see APP.C-4), pens and pencils

II. PROCEDURES

A. Procedures presented in SOP No. SBMP-003b are adopted by reference.

PROCEDURES FOR PREPARATION, IDENTIFICATION, ENUMERATION, AND PRESERVATION OF BIOLOGICAL SPECIMENS (SBMP-004)

I. INTRODUCTION

A. Purpose

This procedure describes the taxonomic methods used to process aquatic macroinvertebrate samples and to preserve specimens for voucher purposes.

B. Minimum Staff Qualifications

Staff implementing this position must meet the minimum classification requirements for Environmental Scientist I published by the Kansas Department of Administration. They also must be well versed in aquatic macroinvertebrate taxonomy and possess a strong familiarity with the invertebrate fauna occurring in the streams of Kansas. The required level of knowledge normally is gained through a combination of college course work and several years of active research in this field.

B. Equipment/Accessories

1. Olympus 9X-110X variable zoom dissecting microscope with Dolan-Jenner bifurcate fiber optic, variable intensity light source or equivalent light source

2. Wild M5A 6X-50X variable zoom dissecting microscope with bifurcate fiber optic, variable intensity light source and spare set of 15X oculars (one fitted with ocular micrometer)

3. Micromaster 40X-630X variable magnification compound microscope with integral light source or equivalent light source

4. Glass or plastic Petri dishes, coarse and fine point dissection probes, fine and extra fine forceps

5. Specimen vials, specimen vial trays, solution of 70-80 percent ethanol and 5 percent glycerine, reference collection housed in locking storage cabinet

6. Microscope slide storage boxes, microscope slides, microscope slide cover slips, Euparal and CMC (CMC-9 or CMC-10) mounting medium, 10 percent KOH clearing medium, glycerine, hot plate for drying and curing slide mounts

7. Taxonomic keys and supporting references

II. PROCEDURES

A. Procedures presented in SOP No. SBMP-004 are adopted by reference.

PROCEDURES FOR OBTAINING LANDOWNER PERMISSIONS (SPMP SOP-002)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the procedures used by the SBMP for determining the identity of property owners and obtaining permission to access sampling sites.

B. Minimum Staff Qualifications

These procedures normally are performed by program field personnel (environmental scientists) but may be performed by virtually any other employee after limited initial training.

C. Equipment/Accessories

Most of the necessary "equipment" is in the form of maps, electronic files, and other informational materials.

II. PROCEDURES

A. A local map of each x-site is generated, identifying site number, stream name, county, and local streams, lakes and roads in the context of the public land survey (township-range-section) grid.

B. County informational resources (register of deeds, appraiser, mapping department, or Internet mapping utility, if available) are contacted to determine the names and addresses of landowner(s) for the x-site. If the x-site falls on or very near a property boundary, information is obtained for all involved property owners. If a public road does not border the x-site property, information is obtained for owners of land associated with alternative routes of access. Internet telephone directory services are utilized to obtain telephone numbers for as many of these individuals as possible.

C. A permission request packet is mailed to each landowner. This packet includes: a request letter with complete contact information for the program, a simplified map of the site, an aerial photo of the site, a brochure describing the SPMP, a site-specific permission form, and a self-addressed stamped envelope. On the permission form, landowners granting site access may (a) impose limitations on access routes, etc., (b) indicate they wish to accompany the field crew during sampling, and (c) request a copy of any resulting environmental data.

D. Permission responses are scored as YES, LIMITED (interpreted as YES), NO, or NO RESPONSE (interpreted as NO).

E. If a response is not received within two weeks, an additional attempt is made to contact the landowner(s). If a telephone number is listed for a landowner in a public directory, at least three attempts are made to contact this individual before designating the response as NO RESPONSE. At least one of these calls is made during an evening or weekend. If no telephone number is available, a reminder postcard is mailed to the landowner. (Note: in cases where no feedback is received (*e.g.*, answering machine does not state the owner's name, or there is no answering machine, or postcards were sent but not subsequently completed and/or returned to SPMP), there is no way to determine whether the landowner was identified correctly or whether any contact was made.)

F. If access to a site requires permission from two landowners (*e.g.*, the stream marks the property line, with separate landowners on each side) and one owner's answer is an adamant NO, the site is coded NO regardless of the response of the other owner.

G. If permission is acquired from the x-site landowner but there is no public access to that individual's property, the x-site owner is asked to recommend a route and assist SPMP staff in obtaining permission from neighboring landowners.

PROCEDURES FOR COMPLETION OF HABITAT DEVELOPMENT INDEX FORM (SBMP-005)

I. INTRODUCTION

A. Purpose

This SOP provides instructions for the completion of the Habitat Development Index (HDI) Form. The form is competed in the field upon conclusion of quantitative biological (macroinvertebrate) collection activities. The resulting HDI score is a numerical expression of the capacity of a stream to support a diverse biological community in the absence of water pollution problems or other significant perturbations. A comparison of HDI scores among different sites is useful in accounting for the possible effects of habitat differences on biotic index values.

B. Equipment/Accessories

1. Measuring pole or D-frame aquatic net with handle graduated in decimeters

2. Hip or chest waders, depending on water depth and prevailing flow conditions

II. CALCULATION PROCEDURES

A. Procedures presented in SOP No. SBMP-005 are adopted by reference.

VEHICLE SAFETY AND MAINTENANCE PROCEDURES (SCMP-002)

I. INTRODUCTION

A. Purpose

This SOP outlines vehicle safety and maintenance procedures used during the collection and transport of SPMP samples. Safety procedures are established to prevent or minimize property damage, personal injuries, and/or loss of life. Maintenance procedures are established to prevent or minimize vehicle breakdowns and to extend the usable life of the vehicle.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also must possess a valid Kansas driver's license and current certifications in standard first aid, cardiopulmonary resuscitation (CPR), and the use of automated electronic defibrillation (AED) devices. Although not required, these employees are strongly encouraged to participate in defensive driving courses offered by some law enforcement agencies and other qualified organizations.

C. Equipment/Accessories

Full size van or other sampling vehicle, as available

II. PROCEDURES

Procedures described in SOP No. SCMP-002 are adopted by reference.

PROCEDURES FOR DETERMINING GEOGRAPHICAL COORDINATES OF MONITORING SITES (BWM-007)

I. INTRODUCTION

A. Purpose

Accurate documentation of geographical position (longitude and latitude) reduces the risk of obtaining environmental samples from the wrong monitoring site and facilitates the analysis of monitoring data through geographical information system (GIS) techniques. The location of all stream sites visited by staff for any type of environmental sampling purpose must be precisely documented using global positioning system (GPS) procedures.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the use of GPS equipment and possess a basic understanding of the underlying technology.

C. Equipment/Accessories

1. Garmin GPS III+ or GPS V or Thales MobileMapper or Thales MobileMapper Pro hand-held GPS unit

2. Garmin MapSource software with City Select maps of North America (version 7 or later)

II. PROCEDURES

A. Procedures described in SOP No. BWM-007 are adopted by reference.

LABORATORY ANALYTICAL PROCEDURES FOR CHLOROPHYLL-A SAMPLES (LWMP-005)

I. INTRODUCTION

A. Purpose

This SOP describes the procedures used by SPMP and cooperating LWMP staff for analyzing chlorophyll-a samples collected from probabilistic monitoring locations.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the analysis of chlorophyll-a and phytoplankton samples.

C. Equipment/Accessories

1. Milton-Roy "Spectronic 501" UV/visible spectrophotometer
2. Wild Heerbrugg, model M40, inverted microscope and modified Sedgwick-Rafter counting cell, settling tubes
3. Fisher Scientific centrifuge (Centrific Model 228)
4. Titration burette, titrant, starch solution
5. Tissue grinder, centrifuge tubes, forceps, vacuum filter manifold, 0.45 micron glass fiber filters

II. PROCEDURES

A. Procedures described in sections I.B and I.C of SOP No. LWMP-005 are adopted by reference.

PROCEDURES FOR COLLECTING WATER CHEMISTRY SAMPLES FROM STREAM PROBABILISTIC MONITORING SITES (SPMP-003)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the procedures used in the SPMP to obtain water chemistry samples from probabilistic sampling sites and to record stream flow conditions at the time of sampling.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the use of GPS equipment and possess a basic understanding of the underlying technology.

C. Equipment/Accessories

1. ArcGIS maps for each sample location
2. Sampling equipment as described in SOP No. SCMP-005, "Procedures for Collecting, Preserving and Transporting Stream Water Samples."
3. Palm Pilot

II. PROCEDURES

B. Sampling locations and their surrounding vicinities may not be familiar to monitoring personnel. To avoid obtaining samples from the wrong site, the following steps must be followed:

1. Before departure from the office, prepare an ArcGIS area map for each site, showing the sampling station, the x-site, area roads, towns, and prominent landmarks. This map, along with county maps, a state gazetteer, and a GPS unit, should allow staff to locate the correct sampling site and understand its relationship to the x-site.

2. While driving to the site, consult maps to determine unequivocally which direction is upstream and which is downstream from the sampling location. Direction of flow (when water forms a continuous channel) may not be readily evident if the water is pooled.

B. If the site is sampleable, as defined in section 4.1.4 of the SPMP QA management plan:

1. Collect water samples from the bridge or stream bank using the procedures described in SOP No. SCMP-005, "Procedures for Collecting, Preserving and Transporting Stream Water Samples."

2. Standing on the bridge deck, or on the stream bank if no bridge is available, and looking upstream and downstream as far as possible, record in the "flow condition" field on the Palm Pilot whether the sample is from water that is visibly pooled (VIS POOL) or from a continuous channel (CON CHAN).

a. If water is visibly pooled:
   i. Record approximate maximum dimensions of pool from which sample is drawn (L×W×D, in meters).
   ii. Record upstream (UP) conditions (wet channel as WET CHAN, dry channel as DRY CHAN, pools as POOLS) and downstream (DN) conditions (WET CHAN, DRY CHAN, or POOLS).
   iii. Take upstream and downstream photos (in that order, if possible). Note order on data sheet or include photo notes in flow condition field (if there is adequate room in this field).

b. If water forms a continuous channel (CON CHAN):
   i. Record flow level (STILL, LOW, MODerate, HIGH, RunOff, etc.). If water is not moving or looks impounded, but is not visibly confined to a pool, record CON CHAN / STILL.

C. If no water is present at the bridge, or if water is present but not sampleable:

1. Do not collect the sample. Instead, record NS (no sample) along with DRY (stream course within bridge right-of-way completely dry) or INSUF (insufficient quantity of water for sampling).

2. From vantage point of bridge or stream bank, record upstream conditions (UP) and downstream conditions (DN), distinguishing between the occurrence of a dry channel (DRYCHAN) or pools (POOLS).

D. If water is FROZEN, use best sampling judgment while recording as much information as possible.

E. If there are any other evident circumstances that could have a strong bearing on recent water quality conditions, especially in pooled situations, record these circumstances on the Palm Pilot and obtain photographs, if possible.

F. Apply abbreviations consistently. Examples of possible comments on the Palm Pilot are provided below:

CON CHAN / STILL / LOOKS BACKED UP, SURFACE SCUM
CON CHAN / HIGH / LIVESTOCK ACCESS
VIS POOL / 10x3x1m / UP POOLS / DN DRYCHAN
VIS POOL JUST DN FRM BRDGE / 5x4x0.5m / UP DRYCHAN / DN WETCHAN MARSH
BRIDGE DRY / UP DRYCHAN / DN DRYCHAN / MANY DEAD FISH
INSUF H20 / UP POOLS / DN POOLS
FROZEN CON CHAN / ICE BROKEN H20 SAMPLED

APPENDIX C

STANDARDIZED FIELD AND TAXONOMIC FORMS

SITE DATA FORM, APP.C-1

SPMP Site data form v2.1, 08FEB07 *1/2*

SITE DATA

Stream ______________________ Station No. ______________ Date ________

County ______________________ Location ______________________

Evaluator(s) __________________ Type ☐ Prob | ☐ Ref | ☐ Other __________

Guests ____

Lat ______________________ Long ______________________

Weather now __________________ Recent weather __________________

Reach length sampled (m) Up ______________ Down ______________

Approx max depth (m) Up ______________ Down ______________

Duration sampled (min) Up ______________ Down ______________

General notes ____

Site sketch

FORMS COMPLETED & SAMPLES COLLECTED

Y	N	
☐	☐	Water column algae samples || Notes ______________
☐	☐	Macroinvertebrate samples || Notes ______________
☐	☐	HDI form || Notes ______________
☐	☐	Flow measurement || Notes ______________
☐	☐	Rapid habitat form || Notes ______________
☐	☐	Mussel search || Samples collected [☐ Y | ☐ N] || Live Mussel Form [☐ Y | ☐ N] Notes ______________
☐	☐	Chemistry samples (optional) || Notes ______________
☐	☐	Fish samples (optional) || Notes ______________
☐	☐	Other samples (optional) || Describe ______________
☐	☐	Photos || Notes & Numbers ______________

Notes ____

PRESENCE & FLOW OF WATER

☐ Sampleable water (>5 cm deep) NOT present in reach (~75 m upstream + ~75 m downstream)
- ☐ Completely dry | ☐ Small puddles apparently only from very recent rain
- ☐ Channel wet in places, or some evidence of subsurface flow

☐ Sampleable water present in reach surrounding X-site (~75 m upstream + ~75 m downstream)
- ☐ Pooled
  - Approx proportion of reach with water present in channel ________ %
  - Approx # pools________ || Max pool size ________ m long x ________ m wide x ________ m deep
- ☐ Water present through entire reach
  - ☐ No visible current (may be backed up)
  - ☐ Visibly flowing || Flow appears [☐ low ☐ moderate/baseflow ☐ slightly elevated ☐ vry elevated]

Notes ____

APPEARANCE OF WATER

Y	N	
☐	☐	Excessively turbid || Notes ______________
☐	☐	Surface scum || Describe ______________
☐	☐	Odor or color unusual || Describe ______________

Notes ____

☐ *On-site QA* ______________ ☐ *Data entry* ______________

APP.C-1 (cont.)

CHANNEL DIMENSIONS AT X-SITE (n.n meters)

Wetted channel width ______________ Bankfull width ________________ Incised width* _______________

Thalweg depth ____________________ Bankfull height ________________ Incised height* ______________

Notes ____

** incised width = incised gully width at floodplain terrace level || incised height = bankfull terrace to floodplain terrace*

CHANNEL IN SAMPLE REACH

Channel is [☐ single | ☐ braided] and is
☐ constrained in narrow valley by [☐ natural | ☐ artificial] features
☐ in broad valley but constrained by incision
☐ in broad valley – relatively unconstrained

There [☐ is | ☐ is NOT] evidence of recent torrent in channel (jumbled substrate, large debris, bank scouring, bark scarring, high waterline). || Notes ______________________________________

Present? ☐ islands ☐ pointbars ☐ backwtrs ☐ tributaries
☐ centerbars ☐ undercuts ☐ side chans ☐ springs, bank seeps, groundwater upwellings

Human chan. modif.? [☐ Y | ☐ N] || Describe ____

Notes ____

SUBSTRATE IN SAMPLE REACH

Dominant channel substrates in reach – choose up to four (score each to nearest 5% – must sum to 100%)

______% Fines (silt, clay, muck <0.06 mm)
______% Sand (>0.06–2 mm)
______% Small gravel (>2–16 mm)
______% Large gravel (>16–64 mm)
______% Cobble (>64–250 mm)
______% Small Boulder (>250–1000 mm)
______% Large Boulder (>1–4 m)
______% Bedrock (>4 m) [☐ Smooth | ☐ Rough]
______% Concrete || Size________________________
______% Hardpan (firm, consolidated fines)
______% Other || Describe ____

Embeddedness/siltation *(evaluate several points in each habitat type; N/A is for natural parent substrate of sand or fines)*

Riffles	[☐ 0-25% | ☐ 26-50% | ☐ 51-75% | ☐ 76-100% | ☐ N/A]
Runs/glides	[☐ 0-25% | ☐ 26-50% | ☐ 51-75% | ☐ 76-100% | ☐ N/A]
Pools	[☐ 0-25% | ☐ 26-50% | ☐ 51-75% | ☐ 76-100% | ☐ N/A]

Notes ____

AQUATIC VEGETATION & AQUATIC/SEMIAQUATIC LIFE OBSERVED

Check if seen ☐ Beaver activity / ☐ Fish / ☐ Amphibians / ☐ Other aq anim________________________

Nearstream veg* includes ☐ grasses / ☐ forbs / ☐ shrubs, woody vines / ☐ sm trees* / ☐ lg trees*

Chan shading	[☐ absent | ☐ light | ☐ moderate | ☐ heavy] || Lgst tree dbh/ht/type ___________	
Aquat. macrophytes	[☐ absent | ☐ light | ☐ moderate | ☐ heavy] || Duckweed?	[☐ Y | ☐ N]
Periphyton	[☐ absent | ☐ light | ☐ moderate | ☐ heavy] || Filamentous algae?	[☐ Y | ☐ N]

Notes ____

** nearstream vegetation is that <10 m from bankfull edge || sm tree = dbh <10 cm / lg tree = dbh ≥10 cm*

LAND USE & HUMAN IMPACT IN SAMPLE REACH

Dominant land uses	*0	B	N	V	*Human impacts*	*0	B	N	V	*Human impacts*	*0	B	N	V
Natural vegetation	☐	☐	☐	☐	Livestock access	☐	☐	☐	☐	Oil/gas well	☐	☐	☐	☐
Woodland/forest	☐	☐	☐	☐	Overgrazing	☐	☐	☐	☐	Bridge/culvert	☐	☐	☐	☐
Row crop	☐	☐	☐	☐	CAFO	☐	☐	☐	☐	Road/path	☐	☐	☐	☐
Grazed/hayed	☐	☐	☐	☐	Water withdrawal	☐	☐	☐	☐	Industr/commerc	☐	☐	☐	☐
Suburban/urban	☐	☐	☐	☐	Irrigation	☐	☐	☐	☐	Dam/weir	☐	☐	☐	☐
Bare soil (not bar)	☐	☐	☐	☐	Drain/pipe	☐	☐	☐	☐	Dredging	☐	☐	☐	☐
Other	☐	☐	☐	☐	Other	☐	☐	☐	☐	Other	☐	☐	☐	☐

**0=not present || B=on bank just adjacent to channel || N = near, within 10 m bankfull edge || V = visible from bank, farther than 10 m*

Other evidence of human activity

☐ Dumping | ☐ Littering | ☐ Fishing | ☐ Swimming | ☐ Other_________________________________

Notes ____

☐ *On-site QA* ________________________ ☐ *Data entry* ________________________

RAPID HABITAT ASSESSMENT FORM, APP.C-2

SPMP RHA form v1.1, 08FEB07 1/2

RAPID HABITAT ASSESSMENT

Stream________________________________ Station No. ________________ Date ____________

County________________________________ Location________________________________

Evaluator(s)____________________________ Type ☐ Prob | ☐ Ref | ☐ Other ________________

This is a [☐ riffle-run | ☐ glide-pool] stream w/ approx ______% riffle, ______% run/glide, and ______% pool in the reach.

Approx length of reach sample ___________ (m) Notes____

____

____

Complete ALL STREAMS section, then complete either RIFFLE-RUN or GLIDE-POOL section, as appropriate.

ALL STREAMS

	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR	Σ
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. 20 19 18 17 16	Water fills over 75% of the available channel; or less than 25% of channel substrate is exposed. 15 14 13 12 11	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. 10 9 8 7 6	Very little water in channel and mostly present as standing pools. 5 4 3 2 1 0	
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern. 20 19 18 17 16	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present. 15 14 13 12 11	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted. 10 9 8 7 6	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. 5 4 3 2 1 0	
8. Bank Stability Left: Right:	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. Less than 5% of bank affected. 10 9 10 9	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. 8 7 6 8 7 6	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. 5 4 3 5 4 3	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars. 2 1 0 2 1 0	
9. Vegetative protection Left: Right:	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. 10 9 10 9	70-90% if the streambank surfaces covered by native vegetation; but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. 8 7 6 8 7 6	50-70% of the streambank surfaces covered by vegetation; disruptions obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. 5 4 3 5 4 3	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height. 2 1 0 2 1 0	
10. Riparian Vegetative Zone Width Left: Right:	Width of riparian zone greater than 18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted the zone. 10 9 10 9	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally. 8 7 6 8 7 6	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal. 5 4 3 5 4 3	Width of riparian zone less than 6 meters; little or no riparian vegetation due to human activities. 2 1 0 2 1 0	

RIFFLE-RUN STREAMS

	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR	
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential; (i.e., logs/snags that are NOT new fall and NOT transient.) 20 19 18 17 16	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). 15 14 13 12 11	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. 10 9 8 7 6	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. 5 4 3 2 1 0	

☐ *On-site QA* ______________________ ☐ *Data entry* ______________________

APP.C-2 (cont.)

SPMP RHA form v1.1, 08FEB07 2/2

2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. 20 19 18 17 16	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. 15 14 13 12 11	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. 10 9 8 7 6	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. 5 4 3 2 1 0	
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is less than 0.3 m/s, deep is greater than 0.5 m.) 20 19 18 17 16	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). 15 14 13 12 11	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). 10 9 8 7 6	Dominated by 1 velocity/depth regime (usually slow-deep). 5 4 3 2 1 0	
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition. 20 19 18 17 16	Some new increases in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools. 15 14 13 12 11	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent. 10 9 8 7 6	Heavy deposits of fine material; increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition. 5 4 3 2 1 0	
7. Frequency of Riffles (or Bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream greater than 7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by width of stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by width of stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by width of stream is a ratio of over 25.	
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0	

GLIDE-POOL STREAMS

	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR	
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are NOT new fall and NOT transient.) 20 19 18 17 16	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). 15 14 13 12 11	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. 10 9 8 7 6	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking. 5 4 3 2 1 0	
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common. 20 19 18 17 16	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present. 15 14 13 12 11	All mud or clay or sand bottom; little or no root mat; no submerged vegetation. 10 9 8 7 6	Hard-pan clay or bedrock; no root mat or vegetation. 5 4 3 2 1 0	
3. Pool Variability	Even mix of large-shallow, large-deep, small shallow, small-deep pools present. 20 19 18 17 16	Majority of pools large-deep; very few shallows. 15 14 13 12 11	Shallow pools much more prevalent than deep pools. 10 9 8 7 6	Majority of pools small-shallow or absent. 5 4 3 2 1 0	
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 20% of the bottom affected by sediment deposition. 20 19 18 17 16	Some new increases in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools. 15 14 13 12 11	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent. 10 9 8 7 6	Heavy deposits of fine material; increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition. 5 4 3 2 1 0	
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note- channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.) 20 19 18 17 16	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line. 15 14 13 12 11	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line. 10 9 8 7 6	Channel straight; waterway has been channelized for a long distance. 5 4 3 2 1 0	

☐ *On-site QA* ____________________________ ☐ *Data entry* ____________________________

HABITAT DEVELOPMENT INDEX FORM, APP.C-3

SPMP HDI form v1.1, 27JUN06 1/1

Habitat Development Index

Stream ______________________ Station No. ______________________ Date ____________

County ______________________ Location ______________________

Evaluator(s) ______________________ Type ☐ Prob | ☐ Ref | ☐ Other ______________________

Notes ____

____

Score only those macro- and microhabitat categories that were sampled.

						Riffles	Pools	Runs
MINIMUM MACRO-HABITAT SCORE	Absent **0**		Present **3**			___	___	___
AVERAGE DEPTHS	Riffles	< 5 cm **0**	5-10 cm **1**	> 10 cm **2**		___		
	Pools	< 30 cm **0**	30-60 cm **1**	> 60 cm **2**			___	
	Runs	< 15 cm **0**	15-45 cm **1**	> 45 cm **2**				___
RIFFLE SUBSTRATE SCORE	% Cobble (1)	0-10% **0**	11-25% **1**	26-50% **2**	> 50% **3**	A		
	% Embeddedness	0-25% **0**	26-75 % **-1**	> 75 % **-3**		B		
Record score in right hand column only if A + B ≥ zero. A+B					___	___		
ORGANIC DETRITUS AND DEBRIS (2)	No organic detritus or debris was sampled. **0**	Only sparsely scattered bits of detritus were sampled. **1**	Large leaf packs or large amounts of scattered detritus were sampled. **2**	Both detritus and debris including logs were sampled. **3**		___	___	___
ALGAL (3) MASSES	No algal masses were sampled. **0**		Algal masses were sampled. **1**			___	___	___
MACROPHYTES (4)	No macrophytes were sampled. **0**	Very few macrophytes or small patches of plants were sampled. **1**	Many macrophytes or large areas of dense growth were sampled. **2**			___	___	___
BANK (5) VEGETATION	No bank vegetation was sampled. 0	Only small amounts of thin bank vegetation was sampled. 1	Submerged tree roots or thick bank vegetation was sampled. **2**			___	___	___
					MACROHABITAT SCORES	___ +	___ +	___
					SAMPLE SCORE	☐		

(1) If percent cobble is ≤10% and boulders or bedrock are present, score box A as 1. Cobble is defined as particles between 6 and 26 cm in diameter.
(2) Organic detritus includes seeds, pods, leaves, small bark, twigs, leaf fragments; may accumulate into piles or packs. Organic debris includes larger sticks, bark, and logs.
(3) Algal masses should be sampled if they provide habitat and not just food.
(4) Macrophytes include floating-leaved, emergent, or submerged aquatic plants.
(5) Bank vegetation includes submerged terrestrial plants, tree limbs, and roots.

☐ *On-site QA* ______________________ ☐ *Data entry* ______________________

LIVE MUSSEL FIELD FORM, APP.C-4

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
BUREAU OF ENVIRONMENTAL FIELD SERVICES
STREAM BIOLOGICAL MONITORING PROGRAM

LIVE UNIONID MUSSEL RECORDING FORM

Date________________________ Collector(s)________________________
Station I.D. #________________ ________________________

Waterbody
Description____
____
Latitude______________________ Longitude ______________________
Legal Description_____, _____, Sec._____, T_____, R_____ County______________________

Scientific Name	Present	Common	Abundant	# of Age Classes
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				

Exotic bivalve species present? Yes_____ No_____
If yes, what species?____
Remarks____
____
____

APP.C-4 (cont.)

KANSAS NAIAD REFERENCE LIST

Scientific Name:	Common Name:	Status:
Order Unionoida		
Family Margaritiferidae		
Cumberlandia monodonta (Say, 1829)	spectaclecase	extirpated
Family Unionidae		
Subfamily Anodontinae		
Alasmidonta marginata Say, 1818	elktoe	endangered
Alasmidonta viridis (Rafinesque, 1820)	slippershell mussel	extirpated
Anodonta suborbiculata Say, 1831	flat floater	endangered
Anodontoides ferussacianus (I. Lea, 1834)	cylindrical papershell	SINC
Arcidens confragosus (Say, 1829)	rock pocketbook	threatened
Lasmigona complanata complanata (Barnes, 1823)	white heelsplitter	
Lasmigona costata (Rafinesque, 1820)	flutedshell	threatened
Pyganodon grandis (Say, 1829)	giant floater	
Strophitus undulatus (Say, 1817)	creeper	SINC
Utterbackia imbecillis (Say, 1829)	paper pondshell	
Subfamily Ambleminae		
Amblema plicata (Say, 1817)	threeridge	
Cyclonaias tuberculata (Rafinesque, 1820)	purple wartyback	candidate
Elliptio dilatata (Rafinesque, 1820)	spike	SINC
Fusconaia flava (Rafinesque, 1820)	Wabash pigtoe	SINC
Fusconaia ozarkensis (Call, 1887)	Ozark pigtoe	
Megalonaias nervosa (Rafinesque, 1820)	washboard	SINC
Pleurobema sintoxia (Rafinesque, 1820)	round pigtoe	SINC
Quadrula cylindrica cylindrica (Say, 1817)	rabbitsfoot	endangered
Quadrula fragosa (Conrad, 1835)	winged mapleleaf	extirpated
Quadrula metanevra (Rafinesque, 1820)	monkeyface	
Quadrula nodulata (Rafinesque, 1820)	wartyback	SINC
Quadrula pustulosa pustulosa (I. Lea, 1831)	pimpleback	
Quadrula quadrula (Rafinesque, 1820)	mapleleaf	
Quadrula quadrula form *nobilis* (Conrad, 1854)	mapleleaf form	extirpated
Tritogonia verrucosa (Rafinesque, 1820)	pistolgrip	
Uniomerus tetralasmus (Say, 1831)	pondhorn	
Subfamily Lampsilinae		
Actinonaias ligamentina (Lamarck, 1819)	mucket	endangered
Cyprogenia aberti (Conrad, 1850)	western fanshell	endangered
Ellipsaria lineolata (Rafinesque, 1820)	butterfly	threatened
Epioblasma triquetra (Rafinesque, 1820)	snuffbox	extirpated
Lampsilis cardium Rafinesque, 1820	plain pocketbook	
Lampsilis rafinesqueana Frierson, 1927	Neosho mucket	endangered
Lampsilis siliquoidea (Barnes, 1823)	fatmucket	SINC
Lampsilis teres (Rafinesque, 1820)	yellow sandshell	SINC
Leptodea fragilis (Rafinesque, 1820)	fragile papershell	
Ligumia recta (Lamarck, 1819)	black sandshell	candidate
Ligumia subrostrata (Say, 1831)	pondmussel	
Obliquaria reflexa Rafinesque, 1820	threehorn wartyback	
Obovaria olivaria (Rafinesque, 1820)	hickorynut	extirpated
Potamilus alatus (Say, 1817)	pink heelsplitter	
Potamilus ohiensis (Rafinesque, 1820)	pink papershell	
Potamilus purpuratus (Lamarck, 1819)	bleufer	
Ptychobranchus occidentalis (Conrad, 1836)	Ouachita kidneyshell	threatened
Toxolasma parvus (Barnes, 1823)	lilliput	
Toxolasma lividus (Rafinesque, 1831)	purple lilliput	
Truncilla donaciformis (I. Lea, 1828)	fawnsfoot	SINC
Truncilla truncata Rafinesque, 1820	deertoe	SINC
Venustaconcha ellipsiformis (Conrad, 1836)	ellipse	endangered

USE ATTAINABILITY ANALYSIS FORM, APP.C-5

USE ATTAINABILITY ANALYSIS SURVEY FORM
AQUATIC LIFE USE

Station Description: ________________________ HUC ________________ Seg ___________

County: ____________________________ ____ 1/4 ____ 1/4 Sec _____ T ____ S R ____ E/W

GPS data: (lat) N ________________________ (long) W __________________________

Form Completed By: _______________________ Date: _____________ Time: ___________

Camera exposure #: Upstream _____ Downstream _____ Other __________________________

Macro habitat type: ☐ **Riffle width** ____ ft. **depth** _____ ave. in ☐ **Run width** _____ ft. **depth** _____ ave. in/ft ☐ **Pool width** _____ ft. **depth** _____ ave. in/ft

Substrate : ☐ Boulder/Cobble (> 3.0") ☐ Gravel (> 0.1" but < 3.0") ☐ Sand (< 0.1") ☐ Bedrock ☐ Silt

Stream Type: ☐ Perennial w/springs ☐ Perennial ☐ Intermittent w/perm pools ☐ Ephemeral

Flow Present : ☐ Trickle ☐ Slight ☐ Moderate ☐ Good ☐ Very Good

Adjacent Land Uses (Classify each bank looking **DOWNSTREAM**)

Left Bank ____________________

Right Bank ____________________

UW= *Ungrazed Woodland* NG=*Native Grass* UR=*Urban*
GW=*Grazed Woodland* PA=*Pasture* PK=*Park*
WE=*Wetland* CR=*Cropland* IN=*Industrial*
RE=*Residential*

Fish Collection Field Data (use additional sheets if necessary) **Mollusk Species Present**

Other Species Present:

☐ **Amphibians** (____) __________________________ ☐ **Reptiles** (____)__________________________

☐ **Crawfish** (____)__________________________ ☐ **Other** (____)__________________________

Comments:

P = Present **C = Common** **A = Abundant**

APP.C-5 (cont.)

USE ATTAINABILTY ANALYSIS SURVEY FORM
(DESIGNATED USES FOR STREAM SEGMENTS)

Designated use is existing if directly observed and attainable if there is evidence which suggests the use is existing including interviews with local landowners. Examples of evidence of actual existing and attainable uses are defined below.

Food procurement – Existing if there is evidence of fishing, waterfowl hunting and furbearer trapping activities. Attainable if there is the presence of sport fish of harvestable size (i.e. – catfish, bass, bluegill, other sunfishes, crappie, or other non-sport fish – carp, white sucker), waterfowl, furbearers, bullfrogs, crawfish, mussels, turtles.

WATER SUPPLY USES

Domestic water supply – Existing if there is evidence of domestic water intake or well within 50' of stream. Attainable if the stream is perennial and has sufficient water (width, depth).

Industrial water supply – Existing if there is evidence of an industrial water intake structure. Attainable if the stream is perennial and has sufficient water (width, depth).

Livestock watering – Existing if there is evidence of livestock access, tracks. Attainable if the stream has sufficient water (width, depth).

Irrigation – Existing if there is evidence of intake structures, stream-side pumps, surface diversions or low head dams. Attainable if the stream has sufficient water (width, depth).

Groundwater recharge – Existing if evidence of the substrate is sand, gravel, fractured bedrock, where spring and seeps occur or stream is a losing stream.

In addition to field observations made for the following uses above, the following databases shall be consulted to determine if there is evidence of actual existing and attainable uses.

- KDHE/BEFS stream recreational UAA database, WIMAS (Water Information Management and Analysis System) database, KDHE/BOW feedlot database, KDHE/BOW water supply database, and reports from KDWP stream surveys.

---Designated Use Assignment-------------------------------------				
Use	Existing	Attainable	Not Attainable	None
FOOD PROCUREMENT				
INDUSTRIAL WATER SUPPLY				
DOMESTIC WATER SUPPLY				
LIVESTOCK WATERING				
IRRIGATION				
GROUNDWATER RECHARGE				

PHOTOGRAPH FISHING, HUNTING, TRAPPING, AND FURBEARER ACTIVITIES AND EXISTING WATER SUPPLY USES

MACROINVERTEBRATE IDENTIFICATION BENCH FORM
APP.C-6

KDHE/BEFS
MACROINVERTEBRATE IDENTIFICATION BENCH SHEET

STATION__________________STREAM/LOCATION____
DATE COLLECTED _______________ DATE(S) EXAMINED _________________ DETERMINED BY ____________________
COLLECTOR(S) ____ TYPE OF SAMPLE (EFFORT) ____________________

	KBS CODE #	A #	I #	P #	TOTAL #		KBS CODE #	A #	I #	P #	TOTAL #
COLEOPTERA						MEGALOPTERA					
						ODONATA					
						PLECOPTERA					
DIPTERA											
						TRICHOPTERA					
						CRUSTACEA					
EPHEMEROPTERA											
						GASTROPODA					
						HIRUDINEA					
						OLIGOCHAETA					
						BIVALVIA					
						TURBELLARIA					
HEMIPTERA											
						OTHER					

KBS CODE#=KDHE KANSAS BIOSYSTEM TAXON UNIQUE CODEA#=NUMBER OF ADULTS IN SAMPLE
I#=NUMBER OF IMMATURE (LARVAE OR NYMPH) P#=NUMBER OF PUPAE IN SAMPLE
(OPTIONAL)
TOTAL ORGANISMS_______ TOTAL TAXA_______ EPT INDEX______ MBI_________ MBI(N)______ HDI_______ D.O.________

SHEET_____OF_____

MUSSEL TALLY FORM, APP.C-7

SPMP Mussel Tally form v3.0, 08FEB07 *1/1*

Project/program: ____________________ Station num: ____________________

Basin: ____________ Co: ____________ Site/stream: ____________________

Date collected: ____________________ Collected by: ____________________

Det by: ____________ QA! by: ____________ Arch by: ____________ Arch date: ____________

Archive numbers: ____________________ Other info: ____________________

Species	Number indivs represented:			From recent material:		Num arch
	Rel	Wea	Rec	Abund (P/C/A)	Num age classes	

MUSSEL SHELL ARCHIVAL FORM
APP.C-8

KDHE KANSAS MUSSEL DISTRIBUTION DATABASE PAGE_____ OF ____

ARCHIVE # ________________ BASIN_______ WATERBODY ______________________________
BIOLOGICAL STATION # _________ CHEMICAL STATION # _________ LAKE STATION # ________________
UAA SEG/STATION ______________________ LAT. ________________________ LONG. ______________________
LOCATION ____
LEGAL DESC. _____________________________________ CO._______ COLL. DATE _____________________
SCIENTIFIC NAME ____
COMMON NAME ____
REL. ABUND. : PRESENT ____ COMMON ____ ABUNDANT ____ ID BY ______________________
SHELL CONDITION: LIVE ____ RECENT ____ WEATHERED ____ RELICT ____
SHELL HEIGHT _________mm LENGTH __________mm COLLECTED BY ______________________
OF AGE CLASSES LIVE OR RECENT ____________________________ ______________________
REMARKS: ____
____

ARCHIVE # ________________ BASIN_______ WATERBODY ______________________________
BIOLOGICAL STATION # _________ CHEMICAL STATION # _________ LAKE STATION # ________________
UAA SEG/STATION ______________________ LAT. ________________________ LONG. ______________________
LOCATION ____
LEGAL DESC. _____________________________________ CO._______ COLL. DATE _____________________
SCIENTIFIC NAME ____
COMMON NAME ____
REL. ABUND. : PRESENT ____ COMMON ____ ABUNDANT ____ ID BY ______________________
SHELL CONDITION: LIVE ____ RECENT ____ WEATHERED ____ RELICT ____
SHELL HEIGHT _________mm LENGTH __________mm COLLECTED BY ______________________
OF AGE CLASSES LIVE OR RECENT ____________________________ ______________________
REMARKS: ____
____

ARCHIVE # ________________ BASIN_______ WATERBODY ______________________________
BIOLOGICAL STATION # _________ CHEMICAL STATION # _________ LAKE STATION # ________________
UAA SEG/STATION ______________________ LAT. ________________________ LONG. ______________________
LOCATION ____
LEGAL DESC. _____________________________________ CO._______ COLL. DATE _____________________
SCIENTIFIC NAME ____
COMMON NAME ____
REL. ABUND. : PRESENT ____ COMMON ____ ABUNDANT ____ ID BY ______________________
SHELL CONDITION: LIVE ____ RECENT ____ WEATHERED ____ RELICT ____
SHELL HEIGHT _________mm LENGTH __________mm COLLECTED BY ______________________
OF AGE CLASSES LIVE OR RECENT ____________________________ ______________________
REMARKS: ____
____

ARCHIVE # ________________ BASIN_______ WATERBODY ______________________________
BIOLOGICAL STATION # _________ CHEMICAL STATION # _________ LAKE STATION # ________________
UAA SEG/STATION ______________________ LAT. ________________________ LONG. ______________________
LOCATION ____
LEGAL DESC. _____________________________________ CO._______ COLL. DATE _____________________
SCIENTIFIC NAME ____
COMMON NAME ____
REL. ABUND. : PRESENT ____ COMMON ____ ABUNDANT ____ ID BY ______________________
SHELL CONDITION: LIVE ____ RECENT ____ WEATHERED ____ RELICT ____
SHELL HEIGHT _________mm LENGTH __________mm COLLECTED BY ______________________
OF AGE CLASSES LIVE OR RECENT ____________________________ ______________________
REMARKS: ____
____
____

CHEMISTRY SAMPLE SUBMISSION FORM
APP.C-9

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF ENVIRONMENT
DATA FORM

PROJECT:

STA_	LOCATION	LAB_ACCESS	FIELD_DATE	CHEM	TOC	HM	DO	NH3	BACT	PEST	RAD	TRIT	TEMP	FIELD_pH	FLOW_CONDITION	COLLECTOR
											NO	NO				
											NO	NO				
											NO	NO				
											NO	NO				
											NO	NO				
											NO	NO				
											NO	NO				

CHAIN OF CUSTODY

Received by: (Signature)	Date / Time	Received by:	
Received by: (Signature)	Date / Time	Received by:	
Received by: (Signature)	Date / Time	Received for lab by: (Signature)	Date / Time

FIELD RECONAISSANCE FORM, APP.C-10

SPMP Field Recon Form v1.0, 08FEB07 1/1

Site ID_______(__) County__________________ Stream name_________________________________

Date & Time _______________________ Crew initials _______________________________________

Waypoint ID: ______________ Photos taken? ☐ Yes / ☐ No

Lat: _______________ Lon: _________________ ☐ Upstream #_______ / ☐ Downstream #_______

☐ **Upstream bridge** || ☐ Known / ☐ New

☐ **Downstream bridge** || ☐ Known / ☐ New

☐ **X-site** ☐ **Other** (describe)____

☐ Water present

☐ Normal ☐ Elevated ☐ Low || Avg. Depth (m): __________ || Max Depth (m): __________

☐ Flowing || Channel width (m): ___________ || Current:_______________

Notes: ____

☐ Pooled || Number of pools visible: _________ || Largest pool dimensions: ____________________

☐ Water not present || ☐ Defined channel present || ☐ Aquatic vegetation present

Aquatic life notes: ____

Physical Access notes: ____

____

Other notes: ____

____

____

Final Decision: ☐ Sample || ☐ Disregard || ☐ Contact Landowner/More information needed

Notes: ____

____

____

Sketch

APPENDIX D

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REFERENCES CITED

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APPENDIX E

GLOSSARY OF TERMS

GLOSSARY OF TERMS

accuracy -- the extent to which a measured value actually represents the condition being measured. Accuracy is influenced by the degree of random error (precision) and systematic error (bias) inherent in the measurement operation (*e.g.*, environmental sampling and analytical operations).

activity -- an all inclusive term describing a specific set of operations or related tasks to be performed, either serially or in parallel (*e.g.*, research and development, field sampling, analytical operations), that in total result in a product or service.

audit -- a systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

bias -- the systematic or persistent distortion of a measurement process which causes errors in one direction (*i.e.*, the degree to which the expected sample measurement is different from the true sample value).

biovolume -- a derivative measure used in reporting algal counts, calculated for each taxon by multiplying the average estimated cell volume by the estimated number of cells and reported relative to the sample volume.

chain of custody -- an unbroken trail of accountability that ensures the physical security of samples, data and records.

comparability -- a measure of the confidence with which one item (*e.g.*, data set) can be compared to another.

completeness -- a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

computer program -- a sequence of instructions suitable for processing by a computer. Processing may include the use of an assembler, compiler, interpreter, or translator to prepare the program for execution. A computer program may be stored on electrical, magnetic or optical media.

corrective action -- any measure taken to rectify a condition adverse to quality and preclude its recurrence.

document -- any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures, or results.

duplicate samples -- paired samples collected at essentially the same time from the same site and carried through all assessment and analytical procedures in an identical manner. Duplicate samples are used to measure natural variability as well as the precision of a method, monitoring instrument, and/or analyst. More than two such samples are referred to as replicate samples.

D-frame -- a long handled net with an opening in the shape of the capital letter D and a bag mesh size of 0.5 mm.

ecoregion -- an ecologically distinctive geographic area defined in the context of a combination of landscape characteristics such as climate, physiography, soils, vegetation (or potential vegetation), geology, and land use.

Ephemeroptera-Plecoptera-Trichoptera index (EPT) -- a surface water quality index based on the number of sampled taxa assigned to three pollution sensitive orders of aquatic insects: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).

generalized random tessellation stratified (GRTS) design -- a site-selection methodology that generates a random, spatially balanced set of sampling points from a map representation of the resource.

independent assessment -- a quality assessment of an environmental monitoring program, project or system performed by a qualified individual, group, or organization that is not part of the program, project or system.

internal assessment -- any quality assessment of the work performed by an individual, group, or organization, conducted by those overseeing and/or performing the work.

macroinvertebrate biotic index (MBI) -- a surface water quality index that reflects the effects of nutrients and oxygen demanding pollutants on sampled assemblages of aquatic (macroinvertebrate) organisms.

method -- a body of procedures for performing an activity in a systematic and repeatable manner.

morphospecies -- informally, an algal taxon that can be recognized by a nonspecialist as distinct from other similar taxa based on external morphology alone.

organization -- a company, corporation, firm, enterprise, or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration.

performance evaluation -- a type of audit in which quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of a technician, analyst, or laboratory.

precision -- the level of agreement among individual measurements of the same property, conducted under identical or very similar conditions.

probabilistic design -- a statistically unbiased approach to sampling based on the random selection of units in the population or resource of interest.

qualified data -- data that have been modified, adjusted or flagged in a database following data validation and verification procedures.

quality -- those features of a product or service that bear on its ability to meet the stated or implied needs and expectations of the user.

quality assurance (QA) -- an integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the user.

quality assurance project (program) plan (QAPP) -- a formal document that describes, in detail, the necessary QA, QC, and other technical activities that must be implemented to ensure that the results of the work performed for a program or project satisfy the stated performance criteria.

quality control (QC) -- the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements of the user.

quality management plan (QMP) -- a formal document that describes a quality management system in terms of the organizational structure, functional responsibilities, and planning, implementation, and assessment of work.

record -- a document, or portion thereof, furnishing evidence of the quality of an item or activity, verified and authenticated as technically complete and correct. Records may include reports, photographs, drawings, and data stored on electronic, magnetic, optical or other recording media.

reference site -- a stream location that is, from an ecological perspective, only minimally impacted by modern (post settlement) human activities based on comparisons to the historical baseline condition or in relation to other, more heavily impacted streams within the geographical region of interest.

relative percent difference (RPD) -- a value calculated by subtracting the lesser of two duplicate analyses from the greater, dividing the difference by the average of the two analyses, and multiplying the result by 100 to convert to percent difference, as represented by the mathematical equation: $RPD = [|A-B|/((A+B)/2))] \times 100$.

replicate sample -- see duplicate sample.

representativeness -- a measure of the degree to which data accurately and precisely represent a selected characteristic of a monitored system.

reproducibility -- a measure of the degree to which sequential or repeated measurements of the same system vary from one another, independently of any actual change in the system.

rapid habitat assessment (RHA) -- a qualitative assessment of biological habitat applied in and near a stream channel.

sampling frame -- in the context of probabilistic sampling, a list or map that identifies, in an unambiguous manner, each member or unit within the population of interest (*cf.*, target population).

standard operating procedure (SOP) -- a written, formally approved document that comprehensively and sequentially describes the methods employed in a routine operation, analysis, or action.

surveillance (quality) -- continual or frequent monitoring and verification of the status of an entity (*e.g.*, monitoring program) and the analysis of records to ensure that specified requirements are being fulfilled.

taxon (singular of taxa) -- the lowest practicable level of identification (*e.g.*, family, genus, species) that can be applied to a group of phylogenetically related organisms.

taxa richness -- a summation of the number of taxa determined as present in a sample.

target population -- the resource (or sum of all units) of interest in a sampling program (*e.g.*, all classified stream segments in Kansas).

taxonomy -- the classification of organisms according to their established phylogenetic relationships

technical review -- a critical review of an operation by independent reviewers collectively equivalent in technical expertise to those performing the operation.

validation -- the establishment of a conclusion based on detailed evidence or by demonstration. This term often is used in conjunction with formal legal or official actions.

verification -- the establishment of a conclusion based on detailed evidence or by demonstration. This term normally implies proof by comparison.